

COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2015

THURSDAY, MAY 1, 2014

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 9:30 a.m., in room SD-192, Dirksen Senate Office Building, Hon. Richard C. Shelby presiding.
Present: Senators Mikulski and Shelby.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF HON. CHARLES F. BOLDEN, JR., ADMINISTRATOR

OPENING STATEMENT OF SENATOR RICHARD C. SHELBY

Senator SHELBY. The subcommittee will come to order.

Administrator Bolden, as one of the most publicly recognized agencies in the Federal Government, NASA serves as an inspiration to many across the globe. For more than 50 years, NASA has pushed the boundaries of human knowledge through exploration and scientific discovery.

The cutting-edge missions and projects historically undertaken by NASA are technologically challenging and risky. A true commitment of resources, coupled with strong oversight, is required for these efforts to stay on schedule and on budget.

In spite of this, NASA's 2015 budget proposal is \$186 million below the current enacted level and contains drastic inequities with respect to program oversight.

This calls into question the administration's level of commitment to a forward-thinking, inspirational space program, I believe. For example, while the Space Launch System, SLS, is subject to strict and necessary oversight, severe budget cuts will ensure delays and unnecessary cost growth.

At the same time, NASA has taken a hands-off approach with the commercial crew and cargo programs, choosing instead to commit seemingly unlimited Federal resources with little to no transparency or accountability. Neither of these approaches, in my view, is acceptable.

And while your statement depicts SLS as critical to NASA's exploration goals, the requested budget does not reflect that commitment. Instead, the budget request maintains a resource level that underfunds SLS and inserts unnecessary budgetary and schedule risks into the future of human exploration.

For the first time in recent memory, NASA has a strategic plan for space exploration that will utilize one platform to meet the needs of multiple exploration missions well into the future. That platform is SLS.

Historically, NASA has planned a single mission and set out to build a program around that mission. Not so with SLS. Once SLS is operational, NASA will be able to provide critical heavy-lift capabilities to short-, medium-, and long-range missions. In short, SLS will provide NASA a versatile platform to conduct a variety of missions.

SLS will allow NASA to break free from its decades-long tether to low-Earth orbit. It will enable NASA to go to an asteroid and achieve the ultimate goal of sending humans to Mars.

In addition, SLS will create significant opportunities for planetary robotic science missions and space-based astronomy. It is the vehicle that will make NASA's goals for exploration possible.

None of this will be possible if we shortchange this effort.

My concerns about the budget are not focused solely on SLS. They also extend to NASA's commercial launch program. And while the commercial cargo program eventually succeeded in delivering cargo to the International Space Station, it came at a significant cost. SpaceX has flown three successful missions to the International Space Station, and Orbital has flown one. These accomplishments should be celebrated.

Yet it is worth noting that these missions could not have been achieved without the investment of nearly \$800 million taxpayer dollars. NASA paid these companies in spite of delayed milestones, shifting completion dates, and a final delivery schedule that was 2.5 years behind. All the while, NASA has little insight regarding the delays and even less about the investments made by the companies.

Today, NASA is using the same flawed model to advance the commercial crew program. Once again, NASA is spending billions to help private companies develop a launch vehicle, but has little to no access to the books and records associated with this investment. None of these companies will publicly disclose investment in the so-called public-private partnership.

The question is, is the Federal Government a majority investor or a minority investor? The fact is, there is no transparency into the true total investment in these vehicles.

Notwithstanding the total Federal investment, I am most troubled that these programs lack an oversight component. Much like the cargo program, we are beginning to see similar issues surface with the crew program.

These issues are not grounded in funding shortfalls, but rather in the capability of these companies to meet their own proposed milestones and deadlines.

Moreover, NASA ceded its authority to investigate these problems when it signed the Space Act Agreements that fund these companies.

I fully recognize that these are not simple efforts. They are technically difficult and extremely risky. That said, the lack of transparency, coupled with the continued demand for additional tax-

payer resources to fund “a commercial venture,” is difficult to rationalize.

While new and innovative ideas often require significant investment and involve significant risk, I believe they cannot come at the expense of other priority programs. They should never be guaranteed funding with little or no oversight.

I plan to work with Senator Mikulski to make NASA’s budget reflect its priorities and to address the inequities in accountability that are emblematic of this request.

General, we welcome you today. We are always glad to hear from you and look forward to the area of questioning. Thank you.

SUMMARY STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Mr. BOLDEN. Senator, thank you very much. I want to thank you and Madam Chairperson, Chairwoman Senator Mikulski, and all the members of this subcommittee for the final fiscal year 2014 appropriations. We are greatly indebted to the hard work that you and Senator Mikulski put into leading the team to come up with the final number.

FISCAL YEAR 2015 BUDGET REQUEST

That budget is allowing us to make substantial progress on our shared priorities, and our fiscal year 2015 request builds on that appropriation. The President’s \$17.5 billion budget request affirms the bipartisan strategic exploration plan agreed to with Congress back in 2010, and it keeps NASA on the steady path we have been following, a stepping stone approach to meet the President’s challenge of sending humans to Mars in the 2030s, and you referred to that in your opening statement.

You should have a copy of this in front of you, but I am going to refer to this chart off and on over the course of my testimony today. But for the benefit of others who are here, this is essentially a pictorial of the roadmap when I refer to the stepping stone approach that we are using to get to Mars. You have already commented on the critical importance of SLS on that, and we can talk about that as I go.

The International Space Station remains our springboard to the exploration of deep space and Mars. Our commitment to extend the ISS until at least 2024 ensures we will have this unique orbiting outpost for at least another decade. This means an expanded market for private space companies; more groundbreaking research and science discovery in microgravity; and opportunities to live, work, and learn in space over longer periods of time.

Later this year, we will see Exploration Flight Test 1, or EFT-1, as we call it, of Orion. NASA is pressing forward with the development of the Space Launch System, or SLS, and Orion, preparing for an uncrewed mission of the two together in fiscal year 2018.

The budget also supports the administration’s commitment that NASA be a catalyst for the growth of a vibrant American commercial space industry. Already, as you pointed out, two companies, SpaceX and Orbital Sciences, are making regular cargo deliveries to the International Space Station.

Later this year, we will move beyond commercial cargo and award contracts to American companies to send astronauts to the station from American soil and end our sole reliance on Russia.

If Congress fully funds our fiscal year 2015 request, we believe we can do this by the end of 2017.

Unfortunately, due to funding levels provided for commercial crew for the past few years, NASA has had to extend our current contract with the Russians and purchase more seats on the Soyuz spacecraft. Instead of investing millions of dollars into the U.S. economy to support American jobs, we will be spending that money in Russia.

While I appreciate all of the funding this subcommittee has provided in recent years, I ask that you fully fund our 2015 request for this critical priority. Budgets really are about choices, and the choice here is between fully funding the request to bring space launches back to American soil or continuing to send millions to the Russians. It is really that simple.

In addition to continuing ISS research, strengthening partnerships with commercial and international partners and building the next-generation heavy-lift rocket and crew capsule to take our astronauts farther into space than ever before, our steppingstone approach includes a plan to robotically capture a small near-Earth asteroid and redirect it safely to a stable orbit in the Earth-Moon system, which we refer to as the proving ground on this chart, where astronauts can visit and explore it.

Our asteroid redirect mission will help us deliver technologies, including Solar Electric Propulsion needed for future deep space missions to Mars. We also enhance detection and characterization of Near Earth Objects (NEO) and improve our understanding of asteroid threats to planet Earth.

NASA's 2015 request continues support for science missions, heading toward destinations such as Mars, Jupiter, and Pluto. It enables NASA to continue making critical observations of Earth and developing applications to directly benefit our Nation and the world. It maintains steady progress on the James Webb Space Telescope toward its 2018 launch.

The budget request also supports missions currently in formulation, such as Europa, and the mission to achieve the science objectives of WFIRST, as laid out in the Astrophysics decadal survey. Our aeronautics program will continue to focus on substantially reducing fuel consumption, emissions, and noise to help make the Next Generation Air Transportation System, or NextGen, a reality.

All of NASA's investments help drive technology and innovation, spur economic activity, and create jobs. That is why the President's Opportunity, Growth, and Security Initiative, with congressional approval, will provide NASA nearly \$900 million in additional funding in fiscal year 2015 to focus on specific areas where we can advance our priorities.

In summary, the fiscal year 2015 budget request advances NASA's strategic plan for the future, will continue building U.S. preeminence in science and technology, improve life on Earth, and protect our home planet while creating good jobs and strengthening the American economy.

PREPARED STATEMENTS

Senator Shelby, I really want to thank you again, you and Senator Mikulski, for the leadership you have displayed with this subcommittee and for the very good funding that we received in the fiscal year 2014 appropriations. I look forward to continuing to work with you and being able to be as happy about funding in the future. So I will be happy to respond to any questions you may have now.

[The statements follow:]

PREPARED STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Madam Chairwoman and members of the subcommittee, I am pleased to have this opportunity to discuss NASA's fiscal year 2015 budget request. The requested budget of \$17.46 billion provides the resources NASA needs to pursue the goals and priorities that the Congress and the Administration have established for the Agency and will ensure that NASA will remain the world's leader in space. A summary of the fiscal year 2015 budget request is appended to this statement.

The President's fiscal year 2015 request supports NASA's continuing quest to extend human presence into deep space and on to Mars. NASA will continue to perform research aboard the International Space Station (ISS), partner with American industry for crew and cargo delivery to low Earth orbit (LEO), develop the Space Launch System (SLS) and Orion crew vehicle, and test our new capabilities in the proving ground of cis-lunar space before sending a human mission to the Red Planet. NASA will also continue to develop a rich array of commercial and international partnerships as part of its overall exploration framework. As we speak, American astronauts aboard the ISS are learning the fundamental lessons necessary to safely execute extended missions deeper into space. Later this year we will see the Exploration Flight Test-1 (EFT-1) of Orion atop a Delta IV Heavy launch vehicle. NASA is pressing forward with development of SLS and Orion, preparing for a first, uncrewed mission in fiscal year 2018.

As a critical element in this long-term exploration strategy, as well as a source of continuing scientific and material benefits to life on Earth, operations in LEO remain among NASA's highest priorities. With the Administration's commitment to the extension of ISS operations through 2024, NASA looks forward to expanded research opportunities with continuing support from our commercial partners for both crew and cargo. Two American companies are launching supplies to the ISS from U.S. soil. NASA will complete a commercial crew competition this summer, and if Congress fully funds our fiscal year 2015 budget request, we believe we can stay on track to launch astronauts to the ISS from American soil by the end of 2017. This capability is critically important to safe/sustained operations, and will end our sole reliance on our Russian partners for this service. The requested funding is required to meet this critical near-term need.

Consistent with the NASA Authorization Act of 2010 (Public Law 111-267) and the National Space Policy, NASA continues to make solid progress on the development of SLS and Orion for a series of test flights including a compelling mission in the proving ground of cis-lunar space to redirect a small asteroid into orbit around the Moon, and to send U.S. astronauts to rendezvous with and explore this target. The proving ground of cis-lunar space also puts the Nation in a position from which we may help our commercial and international partners robotically explore other destinations on that pathway, such as the Moon.

The Asteroid Redirect Mission (ARM) will enable NASA to test powerful Solar Electric Propulsion (SEP) and integrated human/robotic vehicle operations in deep-space trajectories. Like the invaluable ISS, this mission will provide NASA with critical knowledge, experience and technologies for future human exploration missions deeper into space. Drawing on our long-term investments across three Mission Directorates, the fiscal year 2015 request supports continued core capability development and formulation of the integrated mission concept. The overall asteroid initiative also includes enhanced Near Earth Object (NEO) detection and characterization, which will extend our understanding of the NEO threat while providing additional opportunities for investigations of asteroids and demonstrations of technologies and capabilities.

NASA's fiscal year 2015 request for Science supports operation of the world's premier constellation of spacecraft dedicated to exploring Earth, the solar system, and the universe beyond, while we continue to develop the next generation of missions

in pursuit of our Nation's highest priority space and Earth science. The James Webb Space Telescope (JWST), NASA's next-generation successor to the Hubble Space Telescope (HST), continues on schedule for its 2018 launch. In recent months, NASA has completed rigorous testing of the spine of the massive telescope and completed the primary mirrors for integration. As we announced last year, we have begun work on a large Curiosity-scale rover for a 2020 mission to Mars, and the fiscal year 2015 request includes funding to continue pre-formulation activities of a potential mission to Europa, one of Jupiter's moons believed to harbor a vast subsurface ocean. NASA will launch five Earth science missions in calendar year 2014, taking advantage of the unique vantage point of space to secure new insights into our home planet. The Earth science budget will support airborne campaigns to the poles and hurricanes, development of advanced sensor technologies, and use of satellite observations and data analysis tools to improve natural hazard and climate change preparedness.

With NASA's fiscal year 2015 request, our pioneering Aeronautics research program will continue to focus on substantially reducing aircraft fuel consumption, emissions, and noise—and help make the Next Generation Air Transportation System, or NextGen, a reality. NASA's Aeronautics Research Mission Directorate (ARMD) will continue to implement the strategic vision for aeronautics that NASA launched last year, with a focus on addressing the challenges facing the U.S. aviation community—civil and military—in the coming decades.

In essential support of the Agency's broader mission, the fiscal year 2015 request supports an active Space Technology Program to advance cutting-edge technologies, providing an on-ramp for new space technologies, creating a pipeline that matures them from early-stage through flight, and delivering innovative solutions that dramatically improve technology capabilities for NASA, the aerospace sector, and the Nation. The request supports the sustained investments that NASA must make to mature the capabilities we need to achieve the challenging goals that the Congress has set for us. By the end of fiscal year 2014, NASA will test and deliver two candidate designs for high-power solar electric systems for SEP with critical applications for deep-space exploration as well as for Earth-orbital activities. By the end of calendar year 2015, NASA will have completed seven Space Technology missions in 24 months, including demonstration of a deep-space atomic clock for advanced navigation, the green propellant demonstration (an alternative to highly toxic hydrazine), a solar sail to demonstrate propellant-free propulsion, and four small spacecraft missions pioneering new technologies. The Space Technology Program is also developing high performance systems for decelerating spacecraft at Mars, high bandwidth laser communications with the potential to transform communication systems for both space exploration and commercial use, advanced life support technology, advanced robotics, and lightweight composite propellant tanks.

The program laid out in detail in NASA's fiscal year 2015 request continues NASA's implementation of the priorities established for it in the bipartisan NASA Authorization Act of 2010. In the current constrained budget environment, we have designed a balanced program that pursues the Nation's highest priorities in science, exploration, and aeronautics; with a critical technology development program to develop essential capabilities. The fiscal year 2015 request supports the next steps on the way to Mars in a sustainable way. It enables NASA to restore an American capability for sending humans to orbit while continuing development of a deep-space capability for human space flight. This is not an either-or scenario. Each is critically dependent on the other. The request supports the Nation's highest priority science and technology goals for space. NASA appreciates the strong budget support the Agency has received despite a difficult budget environment, and we are fully committed to delivering the world's leading space program on behalf of the American people.

NASA is pleased to be included in the President's Opportunity, Growth, and Security Initiative (OGSI). Under this initiative, NASA would receive nearly \$885.5 million in additional funding in fiscal year 2015 to focus on specific priorities. This initiative recognizes NASA as a critical source of innovation and technology that creates opportunity, economic growth, and ultimately security and prosperity. NASA's funding under OGSI would focus on priority investment opportunities such as an expanded Space Technology Program, reducing risk and enhancing competition in the Commercial Crew Program, continuing currently operating science missions and accelerating work on potential future missions. NASA's portion of OGSI would also enable further development work on SLS and Orion, more fully utilize the ISS, and support additional Earth science mission development, advanced computational fluid dynamics research and increased investment in composite materials.

SCIENCE

With 95 missions in development and actively observing Earth, the Sun, the planets, and the universe beyond, NASA remains the world's premier space science organization and the critical source of information on the home planet. The President's fiscal year 2015 budget request for the Science program includes \$4,972.0 million, with \$1,770.3 million for Earth science, \$1,280.3 million for Planetary Science, \$607.3 million for Astrophysics, \$645.4 million for the James Webb Telescope, and \$668.9 million for Heliophysics.

EARTH SCIENCE

The President's fiscal year 2015 budget request enables NASA to continue to make critical spaceborne measurements of Earth, our home; to conduct and fund a comprehensive, competed scientific research program to turn those measurements into an understanding of our complex planet; and to use the measurements and understanding to develop and demonstrate applications that will provide direct benefit to our Nation, and indeed all of humanity. Today, there are 17 NASA-developed research satellites on orbit, making measurements of more than 60 key aspects of our planet's environment. This past February, in collaboration with the Japan Aerospace Exploration Agency (JAXA), the Global Precipitation Measurement mission (GPM) was launched to provide the first-ever, accurate, global maps of rain- and snowfall over the globe. During the rest of 2014, NASA will be launching four more Earth observing research missions: Orbiting Carbon Observatory-2 (OCO-2) to measure global carbon dioxide concentrations with unprecedented coverage and accuracy; RapidScat to the ISS, to make measurements of ocean wind speed and direction; Cloud-Aerosol Transport System (CATS), also to the Space Station, to measure atmospheric aerosols; and, in November, the Soil Moisture/Active Passive (SMAP) mission to make accurate measurements of soil moisture and freeze-thaw cycling. These 2014 missions will be followed in 2015–2017 by the SAGE-III (Stratospheric Aerosol and Gas Experiment III) instrument to the ISS for atmospheric trace gas profile data, including ozone measurements; the Gravity Recovery and Climate Experiment (GRACE)-Follow On gravity mission with our German partners to measure changes in the Earth's gravity field and water storage, such as aquifer level changes; a constellation of eight smallsats, called Cyclone Global Navigation Satellite System (CYGNSS), to use reflected Global Positioning System (GPS) signals to measure conditions in cyclones and hurricanes; an instrument called Tropospheric Emissions: Monitoring of Pollution (TEMPO) to fly on a commercial geostationary communications satellite, to measure air quality over greater North America; and Ice, Cloud, and land Elevation Satellite-2 (ICESAT-2), to make precise measurements of our planet's rapidly changing ice caps and glaciers.

NASA is now developing the Pre-Aerosol, Clouds and ocean Ecosystem (PACE) ocean color and aerosol continuity mission, and the NASA-Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NI-SAR) mission in collaboration with the Indian space agency to measure solid earth processes, ice flows, global vegetation, and response to disasters and geohazards. The fiscal year 2015 budget request also supports NASA to develop missions that will continue key climate data series, including a set of solar irradiance, ozone profile, and Earth radiation budget instruments, and follow-on capabilities in support of U.S. Geological Survey for sustained land imaging following our successful launch of Landsat-8 just 1 year ago.

ASTROPHYSICS AND JAMES WEBB SPACE TELESCOPE

NASA is making strong progress on JWST, the most powerful space telescope in history, and remains on cost and schedule for launch in 2018. The Webb telescope is the next in a series of astrophysics missions, including the venerable, yet still unrivaled, HST and the incredibly productive Kepler exoplanet mission, which are revolutionizing our understanding of the universe. After launching in 2018, the Webb telescope will travel one million miles from Earth, unfold its sunshield to the size of a tennis court, and keep its instruments cooled to a temperature of 370–387 degrees below zero Fahrenheit (40–50 Kelvin). The Webb telescope will allow us to observe objects even fainter than HST can see, which will allow us to study every phase in the history of our universe, ranging from the first luminous glow after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own solar system. The fiscal year 2015 request will support work to continue testing the integrated science instrument module for JWST, continue the construction of the spacecraft that will carry the science instruments and the telescope, and begin the assembly of the delivered mirror segments into the telescope backplane.

NASA's Astrophysics Program operating missions include the Hubble, Chandra, Spitzer, and Kepler telescopes; and other missions that together comprise an unrivaled, and in many ways unprecedented resource for the study of our universe. NASA is currently working with our German partner to identify a path forward for the Stratospheric Observatory for Infrared Astronomy (SOFIA), a mission with high annual operating costs that cannot be accommodated within the fiscal year 2015 budget request. In fiscal year 2015, NASA's next two astrophysics Explorer missions will continue their development. The Neutron Star Interior Composition Explorer (NICER) will probe the interiors of neutron stars and determine the laws of physics that govern atomic nuclei. NICER will be launched to the ISS in 2016. The Transiting Exoplanet Survey Satellite (TESS) will extend the pioneering work of the Kepler Space Telescope, which showed us that virtually every star in the sky has a planetary system. TESS launches in 2017 and will discover rocky exoplanets orbiting the nearest and brightest stars in the sky in time for the JWST to conduct follow-up observations that will characterize their atmospheres and other properties.

PLANETARY SCIENCE

Planetary Science missions continue to explore the solar system in unrivaled scope and depth. This past November, the Lunar Atmosphere and Dust Environment Explorer (LADEE) was successfully lowered into its optimal position in lunar orbit to enable science data collection, and following the mission's final low-altitude science phase impacted the surface of the Moon, as planned, on April 17. Using its ion engines, the Dawn spacecraft is nearing its next target, Ceres, the largest asteroid in the asteroid belt, with an expected arrival in April 2015. Other upcoming outer planet encounters include the New Horizons mission flyby of Pluto in July 2015 and the Juno mission orbit insertion around Jupiter in August 2016. The fiscal year 2015 budget request also includes funding for continuing pre-formulation activities and studies for a potential mission to Jupiter's icy moon, Europa; with compelling evidence of a liquid water ocean beneath its crust, exploration of Europa is vital to our understanding of the habitability of other planets.

Building on the success of NASA's Curiosity rover on Mars, the fiscal year 2015 request supports plans for a robust multi-year Mars program. In a little more than a year on the Red Planet, Curiosity has landed in an ancient river bed, determined the age of the surrounding Martian rocks, found evidence the planet could have sustained microbial life, taken the first readings of radiation on the surface, and shown how natural erosion could be used to reveal the building blocks of life protected just under the surface. Curiosity is providing vital insight about Mars' past and current environments that will aid plans for future robotic and human missions. The current Mars portfolio includes the Curiosity and Opportunity rovers, the Mars Reconnaissance Orbiter, the Mars Odyssey orbiter, and our collaboration on the European Space Agency's Mars Express orbiter. It also includes the new Mars Atmosphere and Volatile Evolution (MAVEN) orbiter, launched in 2013 to study the Martian upper atmosphere, which will arrive at the Red Planet in mid-September 2014. Future missions include the 2016 Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission, which will take the first look into the deep interior of Mars; participation in the European Space Agency's 2016 and 2018 ExoMars missions; and the new Mars rover planned for launch in 2020.

The fiscal year 2015 budget request includes enhanced funding for NASA's Near Earth Object survey and characterization activities in support of the ARM effort, as well as to protect our planet. Just last year, the Wide-field Infrared Survey Explorer spacecraft was reactivated, renamed NEOWISE and given a renewed mission to assist NASA's efforts to identify the population of potentially hazardous near-Earth objects (NEOs). NEOWISE's first discovery of its renewed mission came on December 29, 2013—a large near-Earth asteroid designated 2013 YP139, which was about 27 million miles from Earth with an estimated diameter of roughly 0.4 miles. NEOWISE can also assist in characterizing previously detected asteroids that could be considered potential targets for future exploration missions.

HELIOPHYSICS

NASA's Heliophysics Program is composed of 29 spacecraft and the associated research to understand the universal physical phenomena of magnetized plasmas and their interactions. These include the influence of the Sun in our local region of the galaxy, the origins of solar variability, and the coupling among various regions at the Earth and other planetary systems. Last year, NASA successfully launched the Interface Region Imaging Spectrograph (IRIS), a Small Explorer mission. Within a few months, IRIS provided a new understanding of how the outer solar atmosphere is heated to over a million degrees. The fiscal year 2015 budget request will support

completion of development of the Magnetospheric Multiscale (MMS) mission, which will launch in 2015 to investigate how magnetic fields connect and disconnect, often releasing tremendous amounts of energy in the process. NASA will continue to develop the Solar Probe Plus (SPP) mission for a planned launch in fiscal year 2018, together with our instrument contributions to the European Space Agency's Solar Orbiter mission; Solar Probe Plus will repeatedly pass through the hot outer atmosphere of the Sun, to within five times the Sun's diameter, which is much closer than any man-made object ever has flown before. Finally, the Explorer missions selected in 2013 to study Earth's outer atmosphere—Ionospheric Connection (ICON) and Global-scale Observations of the Limb and Disk (GOLD)—are in their preliminary design phases for planned launches in 2017.

AERONAUTICS RESEARCH

NASA's Aeronautics research is making air travel cleaner, safer, and more efficient. NASA's fiscal year 2015 budget request provides \$551.1 million to fulfill the Agency's strategic research agenda. This innovative research is aimed at transforming the aviation industry through game-changing advances in the safety, capacity, and efficiency of the air transportation system, while minimizing negative impacts on the environment. NASA's fiscal year 2015 research portfolio is aligned with six strategic research thrusts to directly address the growing global demand for mobility, severe challenges to sustainability of energy and the environment, and technology advances in information, communications, and automation technologies. This portfolio includes those activities in our current portfolio deemed to be the most relevant and critical, as well as new activities focused on high-risk, forward thinking ideas to address aviation's big problems. The Agency will clearly define the most compelling technical challenges facing the aviation industry, and retire these challenges in a timeframe that is supported by stakeholders and required by NASA's customers. Over the next 2 years, NASA will continue to develop, demonstrate, and transition to industry and the Federal Aviation Administration new vehicle and air-space management concepts and technologies to help realize the promise of NextGen, as well as provide technical data, analysis and recommendations to support the integration of unmanned aerial systems (UAS) into the National Air Space. We will strengthen our external partnerships through joint flight experiments using alternative aviation fuels and advanced flight deck and vehicle technologies, and through demonstrations of advanced sensors to improve safety and identify emerging faults before damage occurs. By the end of fiscal year 2015, NASA will close out the 6-year Environmentally Responsible Aviation project with a series of integrated technology demonstrations to demonstrate the feasibility of a suite of technologies to meet our aggressive environmental goals. Through the alignment of our research portfolio to address the most critical challenges facing the aviation sector, NASA will be best positioned to continue supporting the global competitiveness of the U.S. aviation industry that contributes to a \$47 billion positive balance of trade, infuses \$1.3 trillion annually into the U.S. economy and supports more than 10 million direct and indirect jobs.^{1,2} NASA is truly with you when you fly.

SPACE TECHNOLOGY

NASA's fiscal year 2015 request includes \$705.5 million for Space Technology, to enable our future in space, drawing on talent from the NASA workforce, academia, small businesses, and the broader national space enterprise, by delivering innovative solutions that dramatically lower costs and improve technological capabilities for NASA and the Nation.

By the end of fiscal year 2014, NASA will test and deliver two candidate designs for large deployable solar array systems, power processing units, and advanced thrusters to support a flight demonstration of SEP. In addition to being important to the future of human spaceflight and the ARM effort, high-power SEP can enable orbit transfer capability for satellites, and addresses the rapid power demand increases facing today's communications satellites. Having successfully demonstrated a 2.4-meter propellant tank in 2013, NASA will complete testing of a 5.5-meter diameter composite tank to enable lower-mass rocket propellant tanks for future systems, including the SLS. By the end of 2015, NASA will have completed seven Space Technology missions in 24 months, including demonstration of a deep-space atomic clock for advanced navigation that has commercial application for improving

¹“Global Aerospace Industry Takes Off for the World's Largest Aerospace Trade Exhibition in 2012,” July 6, 2012, International Trade Administration.

²“The Economic Impact of Civil Aviation on the U.S. Economy,” August 2011, FAA, Page 24, Table 5 and Page 27, Table 8.

GPS systems, the green propellant demonstration (a higher-performing, less toxic alternative to hydrazine), a solar sail to demonstrate propellant-free propulsion, and four small spacecraft missions pioneering new technologies. Building on recent successes with its Low Density Supersonic Decelerator, NASA plans to conduct high-speed tests—at an altitude of 170,000 feet—of the largest planetary parachute ever developed to enable precise landing of higher-mass payloads to the surface of other planets, with particular focus on infusing advanced capabilities into the Mars 2020 mission and future human exploration missions.

NASA's Space Technology investments are aligned with NASA's Human Exploration and Operations and Science Programs to reduce technological barriers and mission risk, and to foster affordable missions. The Space Technology Game Changing Development effort is delivering advanced life-support, advanced robotics, and battery technologies for system demonstrations planned by Human Exploration and Operations. For Science, Space Technology is improving navigational accuracy, developing advanced computing and avionics, and developing advanced Entry, Descent, and Landing (EDL) solutions, observatory technology, and optical communication technology to transmit large amounts of science data from deep space. Space Technology is partnering with Human Exploration and Operations and Science on many activities, including demonstration of in-situ resource utilization, optical communications, and advanced measurements on Mars. These precursor activities will pave the way and reduce risk for future Mars exploration.

EXPLORATION AND SPACE OPERATIONS

NASA is building the capabilities and knowledge to send humans farther from the home planet than we have ever been before. The fiscal year 2015 budget request for Exploration is \$3,976.0 million with \$2,784.4 million for Exploration Systems Development, \$848.3 million for Commercial Space Flight, and \$343.4 million for Exploration Research and Development. Space Operations, including the ISS and Space Flight Support, form a critical component of the Agency's exploration plans by enabling us to develop the knowledge, experience, and technology necessary for safely living and working in space. The fiscal year 2015 request for Space Operations is \$3,905.4 million, with \$3050.8 for ISS and \$854.6 for Space Flight Support (SFS).

EXPLORATION SYSTEMS

The fiscal year 2015 request will enable NASA to continue to meet its milestones in the development of the Space Launch System (SLS), a rocket system ultimately capable of bringing an unprecedented 130 metric tons of payload to Earth orbit. The Orion program continues on track for an uncrewed test flight later this year. This test flight, Exploration Flight Test-1 (EFT-1), will see Orion conduct two orbits of Earth and reenter the atmosphere at approximately 85 percent of lunar reentry speed of a returning deep-space exploration mission. The test will provide valuable data about the spacecraft's systems—most importantly its heat shield and structure. The flight test article for this mission is already in place at the Kennedy Space Center and being readied for this test. The fiscal year 2015 budget request supports progress toward a first uncrewed test of the Orion and the SLS together, known as Exploration Mission-1 (EM-1) in fiscal year 2018, with the first crewed mission of the two vehicles slated for fiscal year 2021–2022. Orion, SLS, and Exploration Ground Systems (EGS) are using the latest in systems and manufacturing technology to develop the safe and sustainable systems this country needs to extend human presence to Mars. Examples include Orion's use of time-triggered gigabit Ethernet, SLS' use of friction-stir welding on large structures to build the Core Stage, and EGS' replacement of cables from Pad 39B with the latest in fiber optics. In developing the Orion, SLS, and EGS, NASA is building a national capability for the long-term human exploration of space.

INTERNATIONAL SPACE STATION

The fiscal year 2015 request supports the ISS with its international crew of six orbiting Earth every 90 minutes. The Station is making deep-space exploration possible, as we build on the knowledge and experience we are gaining from the astronauts living, working, and conducting research on the ISS. On January 8, 2014, the Administration announced it is committing the United States to the extension of ISS operations through at least 2024. This will allow NASA to complete many of the research and technology development activities aboard the ISS necessary to enable planned long-duration human missions beyond LEO; extend the broader flow of societal benefits from research on the Station, which has already resulted in a discoveries that could have significant medical and industrial implications; provide

NASA and its private-sector partners time to more fully transition to the commercial space industry the transportation of cargo and crew to LEO; instill confidence in the science community that the ISS platform will be available for important, long-term research endeavors; and help cement continuing U.S. leadership in human spaceflight going forward. NASA's plans for the coming year include preparing for an extended duration, year-long human-crewed mission—slated to launch in March 2015—to explore human adaptation to space; and continuing to utilize the ISS to improve our ability to live and work in space, including conducting technology demonstrations enabling future exploration. The Center for the Advancement of Science in Space (CASIS) continues to manage the National Laboratory research being conducted in the U.S. segment of the ISS by an array of organizations, including commercial researchers interested in taking advantage of this unique, microgravity facility. One company, NanoRacks, uses standardized hardware to provide a microgravity research option for scientists working in venues ranging from grade school to academia to industry. During its first 3 years of business, NanoRacks sent 91 investigations to ISS, returned 10 to Earth, and deployed one CubeSat—a new area of focus using satellites that measure about four inches on all sides.

COMMERCIAL CREW AND CARGO

A top priority for NASA and the Nation is to affordably and safely launch American astronauts and their supplies from U.S. soil, ending our sole reliance on foreign providers and bringing that work back home. Under NASA's Commercial Resupply Services (CRS) contracts, Space Exploration Technologies (SpaceX) was awarded 12 cargo flights to the ISS, and Orbital Sciences Corporation (Orbital) was awarded 8 flights. Counting demonstration flights and CRS resupply flights, SpaceX has now completed three cargo missions to the ISS, successfully delivering cargo and returning scientific samples to Earth, with the fourth mission successfully launched to ISS on April 18. Orbital Sciences Corporation has completed their demonstration mission to the ISS and their first contract mission under CRS to deliver crew supplies, research and other cargo onboard the Cygnus spacecraft; the Orb 2 mission is currently targeted for June 10. NASA continues to work with its commercial partners to develop a U.S. commercial capability for human spaceflight and plans to launch American astronauts from U.S. soil by the end of 2017. 2014 will be a pivotal year for NASA's Commercial Crew Program (CCP) as the Agency intends to award development and certification contract by September for the Commercial Crew Transportation Capability (CCTCap) phase that would lead to operational crewed flights to the ISS. Competition is a key to controlling costs over the long term, and NASA's Aerospace Safety Advisory Panel has opined that competition should be maintained until safety confidence is achieved. Through the successful execution of this partnership, we will return to the United States the vital capability to launch astronauts to the ISS from U.S. soil and return them to Earth.

EDUCATION

The Administration is proposing increased interagency coordination of Science, Technology, Engineering, and Mathematics (STEM) education investments, aligned with the 5-Year Strategic Plan released last year by the Committee on STEM Education (CoSTEM). The fiscal year 2015 budget request for Education will enhance the impact of the Federal investment in STEM Education through greater interagency coordination and cooperation in support of a cohesive national STEM strategy focused on five priority areas: K–12 instruction, undergraduate education, graduate education, and broadening participation in STEM education and careers by women and minorities traditionally underrepresented in these fields, and education activities that typically take place outside the classroom. The Office of Education will continue its intra-agency consolidation of certain educational programs to eliminate duplication of efforts and achieve maximum leverage of resources.

The fiscal year 2015 budget request of \$88.9 million consolidates education activities in the Office of Education, including several elements that may be transferred from NASA's mission directorates under a competitive process. The fiscal year 2015 budget request for the Education account includes funding for the National Space Grant College and Fellowship Program, the Experimental Program to Stimulate Competitive Research (EPSCoR), and the Minority University Research and Education Project (MUREP), and STEM Education and Accountability Projects. These education investments link to NASA's research, engineering, and technology missions. Each of these investments provides unique NASA experiences and resources to students and faculty. The budget also provides \$15 million to the Science Mission Directorate to competitively fund the best application of NASA Science assets to meet the Nation's STEM education goals.

CONCLUSION

Madam Chairwoman, thank you for the opportunity to appear before you today to provide you with our progress and status over the past year. I would be pleased to respond to any questions you or the other members of the subcommittee may have.

PREPARED STATEMENT OF HON. PAUL K. MARTIN

Chairwoman Mikulski, Ranking Member Shelby, and members of the subcommittee:

The Office of Inspector General (OIG) is committed to providing independent, aggressive, and objective oversight of the National Aeronautics and Space Administration (NASA), and we welcome this opportunity to discuss the major challenges facing the Agency.

Over past 12 months, NASA has achieved a number of milestones that advanced its space exploration and scientific discovery goals, including a third commercial resupply mission to the International Space Station (ISS or Station) by Space Exploration Technologies Corporation (SpaceX) and the first such mission by Orbital Sciences Corporation, delivery of the final three primary mirrors for the James Webb Space Telescope, and deployment of an Earth-observing weather satellite developed jointly with the Japan Aerospace Exploration Agency.

While acknowledging these and other achievements, we believe that NASA will continue to be challenged to effectively manage its varied programs in the current budget and political environment. We agree with the observation made by the National Research Council in its 2012 report examining NASA's strategic direction and management that, in effect, too many programs are chasing too few dollars at NASA. Accordingly, we continue to view declining budgets and fiscal uncertainties as the most significant external challenges to NASA's ability to successfully move forward on its many projects and programs.

For example, the Administration's proposal to extend operation of the ISS to 2024 comes with a price tag of at least \$3 billion per year. Some space policy experts have expressed concern that NASA will not have enough money to operate the Station while concurrently developing the Space Launch System, the Orion capsule, and other components of its human exploration program. Similarly, following 18 years of development at a cost of more than \$1 billion—a 300 percent increase over initial estimates—the Stratospheric Observatory for Infrared Astronomy (SOFIA) Project achieved full operational capability in February of this year. However, the Administration—citing operational costs of approximately \$80 million per year—has proposed placing the observatory in storage during fiscal year 2015 unless NASA identifies partners willing to assume those costs. We are currently conducting audits examining both NASA's plans to extend the life of the ISS and its management of the SOFIA Program.

In our most recent report on the Top Management and Performance Challenges facing NASA, we identified nine issues:

- Considering Whether to Further Extend the Life of the International Space Station (ISS)
- Developing the Space Launch System and its Component Programs
- Securing Commercial Crew Transportation Services
- Maintaining Cost and Schedule for the James Webb Space Telescope
- Ensuring Continued Efficacy of the Space Communications Networks
- Overhauling NASA's Information Technology Governance Structure
- Ensuring the Security of NASA's Information Technology Systems
- Managing NASA's Infrastructure and Facilities
- Ensuring the Integrity of the Contracting and Grants Processes

The report appended to this statement provides a detailed description of these challenges and the work conducted by our office in each area. In this statement, I will highlight three issues: (1) securing commercial crew transportation services, (2) ensuring continued efficacy of the space communications networks, and (3) overhauling NASA's information technology governance structure.

COMMERCIAL CREW TRANSPORTATION SERVICES

In November 2013, NASA celebrated the 15th anniversary of the ISS. Since retirement of the Space Shuttle Program in July 2011, the United States has lacked the domestic capability to transport crew to and from the Station. Consequently, NASA has relied on the Russian Federal Space Agency (Roscosmos) for crew transportation. Between 2012 and 2017, NASA will pay Roscosmos \$1.7 billion to ferry

30 NASA astronauts and international partners to and from the ISS at prices ranging from \$47 million to more than \$70 million each trip. In addition, the recent dispute in the Ukraine and the resulting U.S. sanctions against Russia has intensified calls for NASA to end its reliance on the Russians for crew transportation.

Currently, NASA is working with three companies—The Boeing Company (Boeing), SpaceX, and Sierra Nevada Corporation (Sierra Nevada)—using a combination of funded Space Act Agreements and more traditional contracts governed by the Federal Acquisition Regulation to develop commercial crew transportation capabilities. As of August 2013, the Agency had spent \$1.1 billion on its commercial crew development efforts. NASA's goal is to secure commercial transportation for its astronauts to the ISS by 2017.

As we noted in a 2013 report, NASA's Commercial Crew Program faces multiple challenges, including (1) unstable funding, (2) integration of cost estimates with Program schedule, (3) challenges in providing timely requirement and certification guidance, and (4) coordination issues with other Federal agencies.¹

With respect to funding, NASA's Commercial Crew Program has received significantly less funding than requested over the past several years, resulting in a 2-year delay of the expected completion of the development phase of the Program. Moreover, NASA has yet to project the total amount of funding required by year, which makes it difficult for the Agency to manage its wider portfolio of spaceflight programs and reduces the transparency of the Commercial Crew Program's budget submissions.

Further, we found that the process for providing timely guidance to partners for satisfying NASA's human rating and certification requirements needs to be improved. If NASA is unable to confirm design requirements and provide certification guidance in a timely manner, NASA's partners companies could face costly and time-consuming redesign work late in system development. Finally, coordination of important safety issues with the Federal Aviation Administration (FAA) and the U.S. Air Force is progressing but has yet to be fully resolved. Resolution of issues such as approval processes for in-flight changes and reentry and emergency diversions require formal agreement between NASA, FAA, and the Air Force.

Failure to resolve the challenges facing NASA's Commercial Crew Program could significantly delay the availability of commercial transportation services and further extend U.S. reliance on the Russians for crew transportation to the ISS.

THE SPACE COMMUNICATIONS NETWORKS

NASA's Space Communications and Navigation (SCaN) Program is responsible for providing communications, navigation, and delivery of scientific data to space flight missions. SCaN is comprised of three networks: (1) the Near Earth Network, which covers low Earth orbit and portions of geosynchronous orbit; (2) the Space Network, which controls the Tracking and Data Relay Satellites (TDRS) through a network of geographically diverse ground systems; and (3) the Deep Space Network, which covers NASA mission needs beyond geosynchronous orbit. Without SCaN services, NASA could not receive data transmission from its satellites and robotic missions or control such missions from Earth, and space hardware worth tens of billions of dollars would be little more than orbital debris. While NASA has provided these services for over 30 years, many of its current satellite communications systems are aging and increasingly difficult to repair.

The OIG is examining the SCaN Program in a series of audits. In the first of these reviews released earlier this week, we assessed NASA's efforts to maintain, replenish, and modernize the Space Network.² The Network, which currently consists of a constellation of nine geosynchronous tracking and data relay satellites and three ground stations, plans to perform more than 175,000 hours of tracking to support 25 to 30 missions in fiscal year 2014. We found that key components of NASA's satellite and ground system projects are not meeting planned cost, schedule, and performance goals. Taken together, these delays and cost growth increase the risk that the Space Network will be unable to continue to provide adequate communication services to NASA and the other Government agencies and private entities that rely on Network services. Further, because of budget reductions and the loss of other expected revenue, the Space Network has a projected \$63 million budget shortfall in fiscal year 2016 and even larger estimated shortfalls in subsequent

¹NASA OIG, "NASA's Management of its Commercial Crew Program" (IG-14-001, November 13, 2013).

²NASA OIG, "Space Communications and Navigation: NASA's Management of the Space Network" (IG-14-018, April 29, 2014).

years that will make it difficult for the Network to meet all planned service commitments.

We recommended that NASA (1) require a revised cost estimate for its ground system project and, based on those results, make necessary adjustments to its baseline commitment; (2) make the appropriate reports to Congress regarding the ground system project; (3) ensure the ground system project passes a termination review before re-baselining; and (4) examine options to increase funding for the Space Network.

NASA'S INFORMATION TECHNOLOGY GOVERNANCE STRUCTURE

Information technology (IT) plays an integral role in every facet of NASA's operations. The Agency spends more than \$1.4 billion annually on a portfolio of IT assets that includes approximately 500 information systems used to control spacecraft, collect and process scientific data, and enable NASA personnel to collaborate with colleagues around the world. Hundreds of thousands of individuals, including NASA personnel, contractors, members of academia, and the public, rely on these IT systems every day.

For more than 2 decades, NASA has struggled to implement an effective IT governance approach that appropriately aligns authority and responsibility commensurate with the Agency's overall mission. Since at least 1990, the OIG and the Government Accountability Office have highlighted a series of challenges stemming from the limited authority of NASA's Chief Information Officer (CIO), decentralization of Agency IT operations, ineffective IT governance, and shortcomings in the Agency's IT security. Because IT is intrinsic and pervasive throughout NASA, the Agency's IT governance structure directly affects its ability to attain its strategic goals. For this reason, effective IT governance must balance compliance, cost, risk, security, and mission success to meet the needs of internal and external stakeholders.

In June 2013, the OIG reported that the decentralized nature of NASA's operations and its longstanding culture of autonomy hinder its ability to implement effective IT governance.³ Specifically, we found that the NASA CIO has limited visibility and control over a majority of the Agency's IT investments, operates in an organizational structure that marginalizes the authority of the position, and cannot enforce security measures across NASA's computer networks. Moreover, the current IT governance structure is overly complex and does not function effectively. As a result, Agency managers tend to rely on informal relationships rather than formalized business processes when making IT-related decisions. While other Federal agencies are moving toward a centralized IT structure under which a senior manager has ultimate decision authority over IT budgets and resources, NASA continues to operate under a decentralized model that relegates decisionmaking about critical IT issues to numerous individuals across the Agency, leaving such decisions outside the purview of the CIO.

With mission critical assets at stake and in an era of shrinking budgets, NASA must take a holistic approach to managing its portfolio of IT systems. To overcome the barriers that have resulted in the inefficient and ineffective management of the Agency's IT assets, we made a series of recommendations to NASA to overhaul its IT governance structure to centralize IT functions and establish the Agency CIO as the top management official responsible for its entire IT portfolio, including empowering the Agency CIO to approve all IT procurements over a monetary threshold that captures the majority of IT expenditures. We also recommended that the Administrator reevaluate the relevancy, composition, and purpose of NASA's primary IT governance boards in light of the changes made to the governance structure and require the use of reconstituted governance boards for all major IT decisions and investments. Finally, we suggested that the NASA Administrator reevaluate the resources of the OCIO to ensure that the Office has the appropriate number of personnel with the appropriate capabilities and skill sets.

Effective implementation of our recommendations requires a cultural shift and significant changes to the Agency's IT management decisionmaking regime, including the realignment of authority and responsibilities. NASA management has acknowledged a need for such change and, in our view, is taking a measured approach to address our recommendations. NASA has requested and we have granted extensions for all of the report recommendations, and NASA anticipates implementing corrective actions by the end of 2014.

In conclusion, the OIG looks forward to continuing our cooperative working relationship with NASA, this subcommittee, and other congressional committees as we

³NASA OIG, "NASA's Information Technology Governance" (IG-13-015, June 5, 2013).

conduct audits and investigations that focus on the Agency's top management and performance challenges.

SPACE LAUNCH SYSTEM JOINT CONFIDENCE LEVEL

Senator SHELBY. Thank you. Thank you, Administrator Bolden.

NASA's internal guidance requires that all major projects have a Joint Confidence Level of 70 percent. I am concerned that the budget request for SLS is a sign that NASA intends to advance a funding profile that supports a Joint Confidence Level well below the 70 percent threshold.

In fact, if SLS passed KDPC using \$1.3 billion as the base funding level, which is the budget request, I believe it will result in a Joint Confidence Level close to 50 percent, essentially a coin toss.

Is there any justification, General Bolden, for advancing SLS with a funding profile that provides the taxpayers a 50–50 chance that it will succeed on schedule and on budget?

Mr. BOLDEN. Senator, we have used the Joint Confidence Level as an indicator. It is sort of like probabilistic risk assessment. You called it a 50–50 chance. I am comfortable with having SLS come in at less than a 70 percent Joint Confidence Level because of the maturity of the system itself.

We are using shuttle main engines. We are getting ready to do main propulsion tests, so we will have the four engines that will go through testing at Stennis that will demonstrate that that system, as we designed it, is—

Senator SHELBY. Do you like where they are at this point in time?

Mr. BOLDEN. I love where we are at this point. I am very confident—I would not approve moving—and I have to admit, I am jumping ahead of myself because it has not come to me yet.

Senator SHELBY. Sure. I understand.

Mr. BOLDEN. We have not done that. But I have been following this pretty closely, and I am comfortable that because of the mature systems that we are utilizing for SLS, compared to some other system, a Joint Confidence Level of 70 percent, which would be great if we had it, is not required to make me feel confident that we are going to be able to deliver.

Senator SHELBY. General Bolden, could you assure the subcommittee that the funding for SLS will be consistent with Joint Confidence Levels required for all other major NASA projects?

Mr. BOLDEN. Senator, as I just said, if I understand your question correctly—

Senator SHELBY. Let me ask it again.

Mr. BOLDEN. Well, I think I understood, but you can't fund enough to get SLS to a 70 percent JCL, and I don't want you to do that. I am not asking for that. That would be unrealistic.

Senator SHELBY. My question, could you assure the subcommittee that the funding level for SLS will be consistent—

Mr. BOLDEN. Yes, sir.

Senator SHELBY [continuing]. Consistent with the Joint Confidence Level required for other major NASA projects?

Mr. BOLDEN. I can guarantee that I will have the same assurance at a lower Joint Confidence Level for SLS that I have for

other projects that are much less mature at a Joint Confidence Level of 70 percent.

A 70 percent Joint Confidence Level doesn't guarantee success, but it has demonstrated, mainly for science missions because we have been religious, if you want to call it that, about adhering to the 70 percent Joint Confidence Level. And it has caused us to bring in projects on time and on cost.

Senator SHELBY. But it is very important that we keep funding SLS at a confidence level, a level that they can finish their job, on time and on budget. Does that make sense to you?

Mr. BOLDEN. Yes, sir. The amounts that we have been submitting in the President's budget each year have been sufficient for my team to assure me that we will be able to make a launch date with SLS and Orion for our——

Senator SHELBY. 2017?

Mr. BOLDEN. 2018 is what we are saying, fiscal year 2018 right now.

And I would caution, until we bring you——

Senator SHELBY. I thought the SLS would support a 2017 launch date, which is the current plan. Is that wrong?

Mr. BOLDEN. As I said, I will be able to tell you within a month for sure what the launch date is to which we are going to commit and what the cost for the program will be. That is what is going to come out of KDP-C, and we haven't crossed that milestone yet.

Senator SHELBY. But the costs have been pretty consistent.

Mr. BOLDEN. Consistent. Yes, sir. I agree.

The amount of money that we have requested and the amount of money we have spent year to year on SLS and Orion has been consistent. And that is what I promise we will continue to do.

ROCKET ENGINE PURCHASE

Senator SHELBY. Thank you. I want to shift gears, just a little bit.

Late yesterday, as you well know, a U.S. Federal claims judge issued an injunction prohibiting the United Launch Alliance, the ULA, from proceeding with plans to buy Russian-made rocket engines. This injunction, if kept in place, would impact, ultimately, the Department of Defense, NASA, and so forth.

Is there a possibility that this injunction could impact NASA's missions?

Mr. BOLDEN. Senator Shelby, I would prefer not to add conjecture on that. That is a matter in litigation right now, and my general counsel has been looking into this since last night. I am not an attorney, so I would not dare——

Senator SHELBY. So you wouldn't know whether this order would impact NASA's ability to pay Russia for rides to the space station?

Mr. BOLDEN. I can only tell you that we have already paid Russia through 2017, so we are not impacted.

Senator SHELBY. So you are ahead?

Mr. BOLDEN. So we are ahead of the game. But that is the way we have to be. We have told our partners that the President of the United States suggests that we extend the life of the International Space Station to 2024. We have told our international partners that we are committed to being able to carry their crew and ours

to the International Space Station on American spacecraft by 2017. And so we are committed to that.

However, to ensure that we can get the crews there through 2017, we have already made the payment. We made it several months ago. So we are okay through 2017.

Senator SHELBY. It is also my understanding, if you can confirm this or to reject it, that it would take a couple years, that we have a backlog of engines from Russia, so there is not going to be an immediate impact.

Mr. BOLDEN. I would defer to our partners, Orbital Sciences and ULA, because I go on what they tell me, and they tell me they have a backlog of engines to cover X number of flights.

So for us, our missions are covered.

ALTERING MISSION PAYLOADS

Senator SHELBY. Sure. What changes would be required to alter mission payloads in the event, down the road, that the launch vehicle could not be used? What is the estimated cost of those changes? Have you gotten that far yet?

Mr. BOLDEN. I will take that for the record.

[The information follows:]

LAUNCH VEHICLES

The changes would depend on when the launch vehicle change occurs in the development and ground testing cycle of the spacecraft. The closer to the launch date the launch vehicle change occurs, the greater the potential impacts. A spacecraft needs to be tested to ensure it can handle the launch vibration, g-force, and acoustic environment it expects to experience during the ascent to space. Changing launch vehicles would require some combination of new testing and analysis to assess the new launch environment impacts to the spacecraft. The impacts and changes could be minor or they could be large depending on the particular spacecraft design and its interaction with the new launch vehicle.

The cost impacts resulting from changing the launch vehicle are time- and circumstance-dependent, but could include: spacecraft retesting and new analysis efforts, potential changes to spacecraft structure, potential requirement to procure a new payload attach fitting that attaches the spacecraft to the rocket and softens the ride, as well as any spacecraft delivery delays caused by this new activity. These costs could be significant, and if a planetary launch opportunity were missed, then likely the costs could run into hundreds of millions of dollars in delay costs. These spacecraft impact costs would be in addition to any costs required to procure a new launch vehicle. NASA has not made a specific assessment of cost impacts due to the scenario-dependent nature noted above.

Senator SHELBY. We hope we won't get that far.

Mr. BOLDEN. Somebody down in the bowels of my ship may be doing that, but I have not asked anybody to do that.

We are optimistic because of our partnership with Roscosmos. It has been steady. It has been firm. And it remains that way. And I remain in contact with my counterpart, who is equally concerned that we maintain that partnership, so I am comfortable.

U.S. RELIANCE ON RUSSIA FOR LAUNCH VEHICLES

Senator SHELBY. Let me get into another area, the same basic area.

Mr. BOLDEN. Yes, sir.

Senator SHELBY. Since retiring the space shuttle, we have relied solely from the Russians to get our astronauts to and from the International Space Station. The crisis in Ukraine and the current

tensions with Russia have caused many people to question the longstanding relationship. We are all hopeful for a thaw there.

In the light of recent decisions regarding sanctions, we are left to wonder what would happen if Russia no longer provided the transportation for our astronauts. And to address these concerns, some have advocated simply investing more heavily in the commercial crew program.

General, is there any company participating in the commercial crew program today that could be ready to take our astronauts to and from the space station within a year? And would additional resources make that possible? And how much would be required? That is a big question, I know.

Mr. BOLDEN. No, no. That is a good question, Senator.

And although at least two of our—in fact, all three of the competitors that I know about, because we are in blackout right now with the contract negotiations or selection—all of them have flights scheduled in 2015 of one type or another, whether they are crewed or uncrewed, and that is normal in a development program.

But just because they fly does not mean that they are ready to be human rated. So, with additional funds, we can accelerate that schedule of their flying, but they have some technical challenges that we should not overlook. So I am comfortable.

We are sticking with the 2017 date that we will have commercial crew available.

Senator SHELBY. And we hope that things work out between us and Russia and the rest of the world, but if Russia were to cut ties with the U.S. or we were to cut ties with them, and they would no longer be able to provide our astronauts transportation to and from the space station, what are our options?

If we had astronauts at the space station, would they get home? Or do you think that is down the road?

Mr. BOLDEN. Senator, a point I think everybody should bear in mind is the partnership that runs the International Space Station is now a 15-year partnership that is pretty well-oiled. It depends not just on Russia and the U.S., but the other three partners.

The way that we have set up the International Space Station, I don't want to say there is an indispensable team member, but the loss of any team member has an impact on the ability to operate the International Space Station. Should we or the Russians choose to pull out, the International Space Station as we know it no longer exists.

The dominant member of the International Space Station team for day-to-day operations, navigation, crew activities, the science on board, is the United States. So if we were to decide to pull out, one of the reasons that we request cooler heads prevail, if we were to pull out, then there is no more of the type of operations that go on, on the International Space Station today.

Senator SHELBY. But the fact remains, does it not—correct me if I am wrong—that we are dependent on the Russians for the transportation?

Mr. BOLDEN. Yes, sir. Today, we are dependent on the Russians. And if for some reason—

Senator SHELBY. And in the near future, too, right?

Mr. BOLDEN. Yes, sir. But if something were to happen that caused us to have to evacuate the International Space Station, the contingency plan, is we have two vehicles that are there, two Soyuz spacecraft.

Senator SHELBY. You think it would work, don't you?

Mr. BOLDEN. We get the crews into the Soyuz spacecraft, and we would come home. Everybody talks about the Russians stranding us. The Soyuz is a three-person crew, a three-person spacecraft. At least two of those people are essential, and usually one of those two essential people is a flight engineer who is an American astronaut.

Senator SHELBY. Okay. You think that would be the escape?

Mr. BOLDEN. That is the escape right now. That is the emergency return vehicle. It is the nominal return vehicle. It is the only vehicle we have. That is why commercial crew support is critical for this Nation.

Where we are today is history, and I don't even dwell on how we got here or anything else. I am looking to the future, and we are really focused on trying to make sure that we have American companies that are ready to fly our astronauts to the International Space Station and other low-Earth orbit destinations that I think are coming by 2017.

And if the Congress funds to the President's requested level in 2015, we are on a good trajectory to get there.

COMMERCIAL CREW PROGRAM

Senator SHELBY. You mentioned the commercial crew investment. And while the commercial cargo program has finally experienced successes, the process is littered with technical challenges, missed milestones, schedule delays, and even requests for additional resources.

That is not unusual now.

Mr. BOLDEN. I am glad you said that, Senator. As you know very well.

Senator SHELBY. Program participants continue to face challenges in meeting the number of contracted space station resupply missions. NASA has chosen to use the same process and methodology to execute the commercial crew program.

My questions are these. Given that the commercial cargo program was 2.5 years behind schedule and \$200 million over budget, what assurance or what can you tell us here at the subcommittee that the commercial crew program will not suffer the same fate?

In other words, how are they doing? Are they going to be basically on time and on the money?

Mr. BOLDEN. Senator, I would like to correct one piece of information about funding. The total NASA investment in the COTS program, the commercial cargo program, was \$684 million. So I don't think that was over any normal expectation.

Senator SHELBY. Okay.

Mr. BOLDEN. Granted, it was delayed, but I would remind everybody of the space shuttle program. I got to Houston in 1980 to become a member of the astronaut corps, and the space shuttle was to have launched in 1978. So when I got there, we were already 2 years behind.

We finally launched in 1981. You will remember very well, being from Alabama, one of the critical delays was loss of a main engine on the test stand at Stennis.

Senator SHELBY. That is right.

Mr. BOLDEN. Those kinds of things happen, and we are trying to make sure that we don't have that happen in the commercial crew development program. There is a difference in the way that we are doing the commercial crew program from a safety oversight perspective.

If you were to talk to Ralph Roe, who is now my chief engineer, and Terry Wilcutt, the head of safety and mission assurance, they are intimately involved in every respect with the safety requirements and the human rating specifications for commercial crew vehicles.

We have been working that for 2 years. We have been under contract with three providers, Boeing, SpaceX, and Sierra Nevada, to make sure that we understand how they are going to develop hazard reports, how they are going to track. So that is much more like the space shuttle program, than say people are familiar with COTS.

We are now entering into a contract phase, where it is much more like it is traditionally done under FAR-based contracts.

Senator SHELBY. General, I will work with you and Senator Mikulski. Senator Mikulski and I have worked together for NASA, working to make sure, to the best of our ability, that NASA is well-funded. We have our job to do on oversight and funding.

I wish we could find more money for all of our programs. We are in tough budget times, as you well know. But we are going to do everything we can to fund NASA.

ROADMAP TO MARS

Could you take just a few minutes again—there is a little glare for me on that chart there—and go over that chart again?

Mr. BOLDEN. Senator, I don't know, do you have a copy of it there on your desk? It will probably be easier—

Senator SHELBY. Just follow it.

Mr. BOLDEN. I will make it really quick.

Senator SHELBY. Don't make it too quick. It is very involved.

Mr. BOLDEN. We intended for it to be simple. Let me stipulate at the outset—

Senator SHELBY. A lot of work went into this.

Mr. BOLDEN. A lot of work went into this.

But you have some purists behind you there on the staff, who are going to be critical of my artwork.

Senator SHELBY. No, they would think you were a master. Go ahead.

Mr. BOLDEN. Although I show four SLS vehicles orbiting Mars, I am taking artistic license. The SLS only goes to low-Earth orbit, and then it falls back to Earth, so bear with me on that. It is trying to show the approximate number of SLS missions that we think it would take for a Mars mission to the surface of Mars.

So other than that artwork, forgive me.

But essentially, it shows where we are today. We are Earth-reliant. We generally spend 6 months in low-Earth orbit. We are get-

ting ready to put up a crew next year. Scott Kelly and his Russian counterpart, they will be there for 12 months, so that will expand the amount of time that we spend in low-Earth orbit.

We still use the space station as our primary staging point to learn about human survival in a microgravity environment.

Where we are moving is to the proving ground. This is what is new, and what people sometimes have a difficult time with. We need to get away from low-Earth orbit, so that we can learn how to operate our spacecraft. We don't know how to fly out there.

Senator SHELBY. What will take you out of low-Earth orbit? SLS?

Mr. BOLDEN. SLS. Now, you see SLS here quite a bit. And I will tell you what is critical, because I want to try to present a complete picture. We are not leaving the Earth-reliant arena ever. We will have to stage there.

So what will happen for us to be successful with deep space exploration, is that we have a firm infrastructure that is in place around low-Earth orbit, multiple facilities like the International Space Station.

So my hope is, within the next 5 to 10 years, you will start to see commercial providers putting other vehicles into low-Earth orbit that will be laboratories, habitation facilities, and the like. That infrastructure will have to be serviced, and that is why we need commercial crew and cargo.

So NASA does not provide transportation to low-Earth orbit anymore. We are out of the access business. So it is really important for everyone to remember we have no exploration program without this low-Earth orbit infrastructure that we are trying to help industry put in place. We are trying to help American industry provide the low-Earth orbit infrastructure.

Senator SHELBY. General, at the end of the day, and, of course, you never know what you find out there, this is a very ambitious project, the Mars mission, and so forth, but so many missions have brought forth so many more things than you imagined at the beginning.

Mr. BOLDEN. Yes, sir.

MARS MISSION POTENTIALS

Senator SHELBY. What would you expect to get out of this? This is an important question.

Mr. BOLDEN. This is a very, very, very ambitious strategy. There are a number of reasons that we believe humans should be on Mars. One of them is to make us a multi-planet species, and that is a kind of funky term, but what it means is that we will demonstrate that humanity can live on more places than just Earth.

The other thing is that it will help us learn a lot about Earth, because Mars, asteroids, and other places in our solar system sort of came from the same origin as our own planet Earth. So looking at Mars and the way it is today, it will help us understand—we need to understand how it got there, because we think it used to be like Earth. What did the Martians not do that got it to be in the bad shape that it is in right now? So that is another reason to go there.

The other reason is because we are an exploring species. We have always done that. My and your ancestors moved away from

the East Coast of the United States to the Mississippi. And they got there and they weren't satisfied, and they wanted to know what was on the other side of the river, and so they continued to go out and to pioneer.

I use the term "pioneer" instead of "explore." Exploring implies we are going to go out and come back, like Lewis and Clark. We are intending to pioneer Mars, which means we are going to put people on that planet to be there permanently.

HUBBLE SPACE TELESCOPE

Senator SHELBY. I remember in this subcommittee years back when people were naysayers about the Hubble telescope. They said, "Oh, gosh, that is a waste of money." But it hasn't been a waste of money. It has been on the cutting edge of exploration.

Mr. BOLDEN. It has been absolutely incredible.

Senator Mikulski, I want to thank you. You weren't here when I thanked you the first time, but I am going to thank you again for all you have done in leading this subcommittee and providing appropriations for NASA.

Senator Mikulski knows very well. It was because of her that we were able to fly the final Hubble servicing mission, STS-125, when the decision had been made at my level that we should try to do a robotic mission. That was demonstrated to be "not" the right way to do it. Hubble today is an absolutely incredible facility that is fully functioning.

Senator SHELBY. A great success.

Mr. BOLDEN. We intend to have the James Webb Space Telescope (JWST) that we launch in 2018 that will be the successor of Hubble. We are in formulation right now to build a mission that some people refer to as WFIRST, but it will satisfy the science requirements of WFIRST, as laid out by the decadal survey.

So it is a progressive understanding of our universe.

Senator SHELBY. I think so, too.

I yield to the chairman.

STATEMENT OF SENATOR BARBARA A. MIKULSKI

Senator MIKULSKI [presiding]. Thank you very much, Senator Shelby. And thank you for opening this hearing. It is part of this very bipartisan trust that we have in each other, and I appreciate it.

Because of the terrible storms in the capital region, it took me 2.5 hours to come from Baltimore today. We have had accidents, mudslides, et cetera. Trains are down.

And I appreciate that we want to show that we can live on Mars. I am kind of dedicated to showing that we can live on Earth right this particular minute.

Again, so I want to thank you. Administrator Bolden, I have already read your testimony, and I want to acknowledge the written testimony of NASA's Inspector General Paul Martin. We had hoped today to have his actual oral testimony, but because of the pending votes, we wanted to move as expeditiously as possible.

PREPARED STATEMENT

Inspector General Martin has identified nine top management performances and challenges facing NASA, all of which this subcommittee strongly believes that it needs to address.

In the interest of time, I am going to ask unanimous consent that my full opening statement be included in the record, and I am going to move right to my points and my questions.

[The statement follows:]

PREPARED STATEMENT OF SENATOR BARBARA A. MIKULSKI

We are here today to review the 2015 budget request for NASA, an agency that all of us care deeply about. We have just one witness here today: NASA Administrator Charles Bolden, who will testify about NASA's budget priorities. NASA Inspector General Paul Martin has also provided written testimony regarding NASA's top management challenges.

This hearing is part of the Senate Appropriation Committee's mission to hold more than 60 hearings in a span of 6 weeks. We are working diligently and intend to have all our appropriations work done by October 1. If successful, it will be the first time that has been accomplished since 1996, and it is an important part of our return to regular order.

Let me start by saying that I am unhappy with NASA's budget. I worry about what it means for the Goddard Space Flight Center, for space science, for Earth science and for NASA's balanced space program.

The President's budget request for NASA this year is \$17.5 billion, which is actually \$186 million below the fiscal year 2014 level of \$17.7 billion.

What I want to hear from Administrator Bolden is an explanation on how a cut like this impacts NASA's ability to carry out its mission. Frankly, my colleagues and I do not agree with how NASA's proposed budget balances these cuts.

The budget before us proposes to cut science funding by \$179 million—or three percent—below fiscal year 2014. The Space Launch System (SLS) and Orion are cut by \$365 million—or 13 percent—below 2014.

NASA needs this funding to support a balanced space program that funds human space flight, reliable and affordable transportation systems and space science. I want to see NASA continue its Space Station operations.

It is also important to me that the agency support reliable and affordable transportation systems, such as a 2014 test launch for Orion, a 2017 launch for SLS and robust funding for a commercial crew to get to the International Space Station lab facilities without relying on the Russians.

Finally, I want a space program that keeps NASA's near term science launches on schedule and on-going missions on track. I am very concerned that the 2015 budget does not invest adequately in future science missions.

For example, the proposed fiscal year 2015 budget reduces Earth science by \$56 million, cuts astrophysics by \$61 million, inadequately funds a future Dark energy mission and cuts the on-going Hubble mission by 23 percent. That's too much, too soon. We must keep making progress on the scientific missions recommended by National Academies' decadal surveys now and in the future.

I am pleased that NASA is extending the life of the International Space Station through 2020. Thank you. The Space Station is so much more than what everyone saw in the movie "Gravity". It is our national lab in space, and I am so proud of the astronauts there.

As of now, there are six people aboard the ISS—two NASA Astronauts, three Russian Cosmonauts and one Japanese Astronaut. They all arrived there on the Russian Soyuz. That's because when the Space Shuttle retired in July 2011, the United States lost its capability to fly astronauts into space. The ongoing events in Ukraine have me worried about the uncertainty created by that reliance on Russia. Is NASA doing all it can to quickly taper our space program's reliance on Russia?

The Members of this Committee have a space coalition that supports NASA's balanced missions. But to keep that support during frugal times, we need to be able to count on NASA to focus on improved oversight and accountability.

At the request of this Committee, the Government Accountability Office (GAO) has been assessing NASA large projects since 2009. GAO's most recent assessment shows that NASA's cost and schedule performance is improving and that cost growth and schedule slips continue to decrease. That's good.

The average cost overrun is down from 4 percent to 3 percent, while average launch delays are down from 4 months to under 3 months. And I'm especially grateful for NASA's efforts to keep the James Webb Space Telescope on schedule and on budget.

Many challenges remain. NASA needs to remain vigilant. More than 80 percent of the agency's funding is awarded by contract—that's more than \$14 billion of their 2015 request.

Their Inspector General has identified ongoing agency challenges, ranging from project and contract management to cybersecurity. We appreciate Inspector General Martin's written testimony on how NASA has implemented his recommendations.

I want to wrap up by thanking the men and women of NASA. From the machinists grinding precision parts for spacecraft exploring the galaxy, to computer operators compiling data used for forecasting or understanding the Big Bang—they all do great work.

NASA is where scientists are rewriting textbooks and winning Nobel prizes. But it's also where astronauts risk their lives to make discoveries in space. Their work is vital for understanding the boundaries of our universe, expanding the boundaries of science and keeping our tech economy moving forward.

We need to make sure NASA's budget is adequate to meet that mission.

Senator MIKULSKI. First of all, we want to say good morning to you, Administrator Bolden.

Mr. BOLDEN. Good morning.

Senator MIKULSKI. I am sorry I couldn't be here earlier, that we couldn't have had coffee together and so on. We appreciate your continual service to our country, and we also, as I said, want to thank the inspector general.

Also, I know Senator Shelby and I really want to thank the men and women who work at NASA, and the men and women who are the civil servants at NASA, and we want to thank also the contractors who do so much of the important work. They have been under so many stresses.

Doing space and aeronautics in and of itself is challenging, challenging technology, challenging environments. It is not just like the movie *Gravity*, which was mesmerizing, where it had a happy ending, because they faced everything from sequester to slam down, shut down. It has been a rough road.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. And so we really want to thank them for their continual dedication.

There are many issues to discuss, one of which is the aging workforce at NASA, impending retirements, the recruitment and retention of others. But let's get right to the appropriations.

FUNDING REDUCTIONS

First of all, I was deeply troubled to receive the President's budget. I was deeply troubled in the area of NASA because there was a reduction of \$186 million from fiscal 2014, which we already knew was tight.

I can't thank Senator Shelby enough for the way he helped move that omnibus. It didn't happen because of Barbara Mikulski. Behind me there was a whole lot of us, including my vice chairman. We worked together.

So when we saw this \$186 million, it was deeply troubling.

Now, I am committed to a balanced space program, human spaceflight, reliable transportation system to both the space station and areas beyond, the space science, and, of course, aeronautics.

So we saw \$186 million cut, and then to rub raw the sores of discontent, we also saw that Goddard Space Agency was cut by \$200 million—\$200 million in very important science programs.

Senator Shelby has also raised the cuts in SLS and Orion, which are the kind of hallmark for going out there.

MAINTAINING A BALANCED SPACE PROGRAM

So I am going to go right to my question about how to maintain a balanced space program when the two major programs—I know Senator Shelby has looked at those things related to a heavy-lift capacity. Are we really funding a lot of things at the expense of space science? Why did you take \$200 million out of Goddard?

Mr. BOLDEN. Senator, as you said, and I appreciate your enthusiasm for a balanced portfolio, we have sought to put in place a balanced portfolio for the agency.

There are a number of projects that are in formulation, in which Goddard will play a critical role. The funding for those projects have not yet been designated and distributed. We look at the long-range viability of each of our centers, and I firmly believe that Goddard will continue to be an integral part of all the programs that we have going forward.

I mention the formulation of a mission to seek out to satisfy the objectives of WFIRST as laid out by the decadal survey. None of that is reflected yet in the NASA budget in the out-years, or in the Goddard budget. So those will be areas that will be plussed-up.

We look at all of the centers. I sit down with the center directors and Robert Lightfoot, and we look at what they see for the out-years, because stability is what the center directors seek. Stability in funding is something that you have said is a goal of yours, and I applaud you for that, because nothing will be as critical as stability in funding in the out-years for our planning and for centers to feel that they know where the future is. The instability in funding has been the thing that has us where we are right now.

SCIENCE BUDGET

Senator MIKULSKI. I understand the stability and funding issue. It is not only me, but it is Senator Shelby and, I must say, our mutual leadership. So that is why we worked with Senator Murray and Senator Sessions to pass a budget that canceled sequester. It was a tough swallow. I would have wanted to do more in some areas, less than others, my colleague. But that is to be debated.

So you want to talk about future missions and decadal and is Goddard going to have a future. But it has a future now in its bread-and-butter issues. The two bread-and-butter issues in telescopes are keeping Hubble on track to continue be the greatest telescope since the Galileo and the James Webb.

So with James Webb, we know that there has been a decrease of \$13 million. I don't dispute that, but the margins are very thin and they are at the high-risk area. I have been out there. We have been there together. We have seen some of this. It is very exciting.

Hubble in the meantime continues to fly and continues to dazzle and continues to write the science books and continues to make Nobel Prize winners. So at the same time, Hubble has been cut \$23 million.

Now I know some might say that is an accounting adjustment, and we are going to fix it in 2016. I don't know what 2016 is going to be. I know what 2015 is going to be.

So this is what we need to do. I don't want to talk about future missions. I want to talk about now. I am going to talk about Earth science, heliophysics, planetary science. I don't want science to be a bank account for other projects that might or might not happen in the future.

Mr. BOLDEN. Senator, I promised when I became the NASA administrator that we were not going to use science as a bank for any of the programs in the agency, and I think we have done that. We have not moved, and I refuse to move any funds out of science into another program area.

What we are looking for is a balanced portfolio in the science, inside the Science Mission Directorate. And as I said, the missions in formulation—when Chris Scolese talks about the future, which is exactly what he is saying, when he looks at the out-years, he doesn't see funds for WFIRST, he doesn't see funds for—

EARTH SCIENCE BUDGET

Senator MIKULSKI. I don't want to be beating a dead satellite here, but Earth science is \$56 million below fiscal year 2014. And fiscal year 2014 was already tough.

Mr. BOLDEN. Senator, we are finding that we have efficiencies in the way that we fly Earth science missions. For the first time ever, we have two Earth science missions that are going to the International Space Station this year. They are significantly less cost to the taxpayer.

And we are trying to find more and more ways to get efficiencies in our programs.

So I think in the long run, when I sit down with Chris Scolese at Goddard and Charles Elachi out at JPL and Steve Jurczyk down at Langley, the people who spend most of their time thinking about Earth science and planetary science, we will find that there is a balanced distribution of the funds in the out-years, once we get a lot of the formulation—

SPACE STATION EXTENSION

Senator MIKULSKI. Well, you and I really strongly disagree on this, Administrator Bolden. We really do strongly disagree on this.

But I want to go to something we do agree on, and that goes to the extension of the life of the space station.

That was a bold decision on your part. But both Senator Shelby and I, along with our colleagues, want to make sure that we get research value for that. And what has been so, I think, strong has been the bipartisan support of both the appropriators, and when we look at our authorizers—and back in the day, it was Senator Nelson and Senator Kay Bailey Hutchison—the whole idea of what could be done on the space station was exciting. So let me get to my question about that.

In order for the space station extension to be viable, we need to be able to get there.

Mr. BOLDEN. Yes, ma'am.

NASA-RUSSIAN COOPERATION

Senator MIKULSKI. We are all deeply troubled about what is going on in Ukraine, and the behavior of Russia and Mr. Putin's words and so on. We leave that to our President and our Secretary of State.

But what we are worried about is the reliability. As I understand it, there are two ways that the space station, we have to be able to get there. So one, we have to keep commercial crew on track, and the other is, as we impose sanctions with the Russians, will this jeopardize their cooperation on Soyuz? So let's put Soyuz here.

Let's go to commercial. One, how do you see the commercial cargo staying on track, particularly with the Orbital-ATK merger?

RELATIONSHIP WITH RUSSIA

And then second, could you bring us up-to-date on the relations with the Russians. And no matter what happens, do you think that will be strong, or is that in jeopardy? Can you answer both those?

Mr. BOLDEN. Senator, as I mentioned to Senator Shelby earlier, I could not state more strongly that the relationship between Roscosmos and NASA is solid. I communicate with my counterpart on a regular basis. Bill Gerstenmaier, who runs human exploration, was just there for a Soyuz launch, about a month ago, and he continues to work.

I think that you know that Sergei Krikalev, who was a former crew member of mine, is in the leadership there.

Senator MIKULSKI. So you are all okay and doing Kumbaya now, but it is a delicate situation internationally. We are going to be escalating our sanctions, and I am not talking about your current relations. I am talking about, are the future relations, in general, in jeopardy?

And do you think that our aggressive pursuit of sanctions—and I am supporting the President in his sanctions. We have to take a strong stand, and we are proud of our NATO alliance.

So you see where I am heading?

Mr. BOLDEN. Yes, ma'am. Senator, as much as I would love to delve into diplomacy and things, because I do think I have a worthwhile opinion, but I am going to resist the temptation to do that. I am going to say that what I am striving to do is continue the relationship I have with Mr. Ostapenko, who heads Roscosmos, to make sure that he does get everything that he can across in Russia to calm down the diplomats and the politicians there, as we are trying to do here in the U.S., to help people understand the importance of this partnership.

We are trying to accelerate as rapidly as we can the availability of commercial crew, so that we can launch our astronauts from—

Senator MIKULSKI. Well, let's move on to that. But I think, really, Senator Shelby and I would like to be able to stay in touch and also to keep an eye on it. I think it is a very delicate situation.

Mr. BOLDEN. Yes, ma'am.

COMMERCIAL CARGO

Senator MIKULSKI. So let's go to commercial vehicles. So what do you think? How are we doing on commercial cargo? And then let's

go to commercial crew, both from a budgetary standpoint, and when do you think, what are the targets for commercial crew?

Mr. BOLDEN. Senator, we are in relatively good shape. We are in great shape with our commercial cargo right now, because Orbital Sciences, that does use a Russian engine, we are told, has enough engines in their stockpile to get through this contract.

We are in the process now of getting ready to negotiate a new contract for commercial cargo after 2016. Orbital, like most other companies, is working with the engine manufacturers to see if there is not a U.S. option for engines.

So those are things that they have been doing long before this recent crisis took place, because they would like to get newer engines. The NK-33, which is now the AJ26, is an old Russian rocket engine. Senator Shelby knows we have been trying to get away from that and get to new technology as quickly as we can, and that work is underway. SpaceX has an American-generated, American-manufactured, engine, so that part of the commercial cargo is stable, and should not be affected at all.

COMMERCIAL CREW

Senator MIKULSKI. Now let's go to commercial crew.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. What are your target timetables? Do you have the resources to meet those timetables? Could you elaborate?

Mr. BOLDEN. Senator, again, I have to thank you for fighting the good fight with commercial crew and trying to keep our funding as high as possible. Because of your efforts and that of Senator Shelby, the 2014 mark, while not what we would have wanted, was enough that, if matched with the President's request for \$848 million in 2015, will keep us on target for 2017 availability of American capability to launch our crews to space safely and reliably through competition, which we feel is absolutely necessary.

Senator MIKULSKI. Well, as I understand it, commercial crew is funded at \$848 million. It is \$156 million above fiscal year 2014, and your goal was to send astronauts to the space station on U.S. rockets by 2017. Is that right?

Mr. BOLDEN. That is correct. That is the present goal.

Senator MIKULSKI. So you envision American astronauts to be on a vehicle that can go to the space station by 2017?

Mr. BOLDEN. That is correct. In an American vehicle.

Senator MIKULSKI. Excuse me, that is exactly right.

And do you feel that you have the resources to be able to accomplish that? We are obsessed with the safety—and I know you are. Boy, we are committed to the safety of our astronauts.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. Exploration is great. We love extending the life of the space station. But we are for the safety of those men and women who are so daring to do this.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. So whatever we do, we know that there is always risk. We know that.

Mr. BOLDEN. Senator, I cannot overemphasize this. As long as you continue to fight as you have been doing, you and Senator Shelby, on the importance of commercial crew, if we can get the

President's request funded at \$848 million, based on having the \$696 million that we have this year in 2014, we should be on target for an American capability in 2017.

Senator Shelby and I were talking earlier, is it possible to accelerate that? With more funds, it is possible to accelerate that, but we are sticking with a 2017 crew launch availability.

Senator MIKULSKI. Including all the human ratings?

Mr. BOLDEN. That is all the human ratings.

Senator MIKULSKI. But if we fund it at fiscal year 2015, this will mean competition of two providers? Do you intend to shrink that? I mean, right now, there are more than two providers.

Mr. BOLDEN. If you allow me, I will stay away from saying how many there are going to be because I don't know how many we are going to select. But what I want to assure you is, no matter how many providers we select, the vehicle will be safe. It will meet our requirements in every regard. And it will be available in 2017.

So that is what I can promise this subcommittee, and that is what is important to us right now.

Senator MIKULSKI. Senator Shelby.

Senator SHELBY. I didn't have any other questions. I just have some observations.

Senator MIKULSKI. Well, before you do, I know you have been very interested in this commercial—

Senator SHELBY. We got into it a little earlier, and I appreciate you continuing in that vein of questioning.

CYBERSECURITY AT NASA

Senator MIKULSKI. Well, we could talk about our telescopes, but I understand they are on track, but for the James Webb, this is a very difficult one.

I want to go to another issue that is of keen interest, again, on both sides of the aisle, which is cybersecurity at NASA.

As I understand it, NASA has some pretty big challenges. This has been identified by you. It has also been identified by the inspector general.

The inspector general talks about inadequate tools for real-time monitoring, a high amount of unprotected network access points, uncoordinated adoption of cloud computing, failure to use best practices in managing IT vulnerabilities.

Do you want to comment on the I.G.'s rather stern assessment of the cybersecurity?

Mr. BOLDEN. Senator, I will say as they did with Congressman Wolf in an earlier hearing. We recognized long before anyone else, I recognized the first day I became the NASA Administrator, that we had a big hill to climb in terms of IT security, how we run our IT cybersecurity program, because we are among the largest areas threatened in the Federal Government.

We have taken a number of actions. Now we have worked with NAPA to do a study of our foreign national access management. That study also included cybersecurity, IT security. It identified 27 actions, recommendations that they gave to us. I accepted every single one of those 27 actions. We have prioritized them in coordination with NAPA, in what we think are critical areas of importance.

So we go down the list on a risk basis. We are already working on the top six. They are funded with internal NASA funds that we already have available.

When we get ready to submit the 2016 budget request, we will have a pretty good idea how much additional funds we need to put into IT security and cybersecurity. We are going to have to put additional people on it. We are advertising right now for a manager for a foreign national access management program.

Senator MIKULSKI. Who is in charge of this?

Mr. BOLDEN. I am. I am ultimately in charge, but my chief information officer—

Senator MIKULSKI. But you are in charge of a lot.

Mr. BOLDEN. My chief information officer is Larry Sweet. I brought him up from the Johnson Space Center. He was the chief information officer there. He was competitively selected.

Senator MIKULSKI. So is Mr. Sweet—in other words, have you put into place a management structure to oversee the cyberstructure, because it is very uneven.

Mr. BOLDEN. We have.

Senator MIKULSKI. We are worried about protecting “dot mil,” okay? I think “dot gov” is very nifty. And then, of course, there are the challenges to “dot com” that we see in the marketplace every day.

I can’t control “dot com,” but we can do something about “dot gov.” So we really need kind of the edge of the chair on this.

Mr. BOLDEN. Senator, when you talk about leadership, there are three people, three buttons that I push. Joe Mahaley heads our operational security branch. Robert Lightfoot, who is the associate administrator, has overall oversight for this. Senator Shelby knows him very well from his time at the Marshall Space Flight Center, and then Larry Sweet.

So between the three of them, those are the three who I go to who can answer any questions that may come up about our approach and our plan in the out-years for shoring up our cybersecurity, our IT infrastructure.

One of the basic problems we had was governance. There was no centralized governance for IT. The chief information officer for the agency didn’t control anybody except people at NASA headquarters. That is unsatisfactory.

Senator MIKULSKI. You have been the administrator for 5 years.

Mr. BOLDEN. And we now have, just as public relations, or public communications, legislative affairs, information, IT, that all comes to headquarters for coordination. We don’t order people what to do. We don’t control the funds at the center level, but we coordinate it such that funds are spent in—

Senator MIKULSKI. Well, I appreciate the progress you have made. You have had a job for 5 years.

Mr. BOLDEN. Yes, ma’am.

Senator MIKULSKI. This is not a new problem.

Mr. BOLDEN. No, ma’am. Not by any means.

Senator MIKULSKI. Cyber has been an ongoing problem. And we hope that there continues to be a sense of urgency.

Senator Shelby.

NASA PRIORITIES

Senator SHELBY. I have no other questions, other than to tell General Bolden, our administrator, that we do have challenges. You have challenges, and both of us believe that we want to fund these missions.

Mr. BOLDEN. Yes, sir.

If I go back to cybersecurity, we have now, because of Larry Sweet, Robert Lightfoot, and Joe Mahaley, we now have dates assigned when we expect that we will answer the mail, when we will have actions complete. Some of those dates, unfortunately, because of budget limitations, are not next year. They may be 2016 or 2017. But we have a plan to get there. As I said, it is a risk-based plan. The things that leave us most vulnerable we are trying to take care of right now, so that we are shoring up. We are sticking our finger in the dike while we have somebody behind us building another better dike. But we are using a risk-based method for putting money against the problems that we have.

Senator MIKULSKI. Well, we agree, I think, all of us, on the goals of NASA. We are troubled over these continually shrinking resources. Remember, we are given a cap on discretionary spending.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. And there are also firewalls.

We note that NASA's highest funding level was in 2010 when it was \$18.7 billion. That is roughly about \$1 billion less now. So we are not on an upswing here. There is not new money on the horizon, so I think we have to be candid about that.

We are looking at this in a very strong way. We are committed on a bipartisan basis to a balanced space program. And we have big challenges ahead, and we need to cooperate with you. And we do appreciate your longstanding service, both in other capacities serving the Nation and now.

But though we agree on the goals, I am not so sure we agree on some of these priorities in here.

So we have taken your testimony, and we found it very informative.

Again, I really apologize for being late. I had hoped to be here earlier.

And thank you, Senator Shelby.

And so we need to have ongoing conversations. We hope that within the next week, between now and next Thursday, that we have our allocations ready and that we will begin to do our mark-ups. And it would be our goal to have CJS through the full committee before the Fourth of July break.

So that is our goal. That is our timetable.

And because of the strong bipartisan support, and strong tell-it-like-it-is from Senator Shelby, I think we will get it.

So thank you very much, and we will be in touch with you and your staff.

ADDITIONAL COMMITTEE QUESTIONS

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED TO HON. CHARLES F. BOLDEN, JR.

QUESTIONS SUBMITTED BY SENATOR DIANNE FEINSTEIN

SCIENCE

Question. I have long supported the National Aeronautics and Space Administration's (NASA) Mars exploration program, which has really become a crown jewel of the agency after the successful Curiosity rover landing.

However, I am concerned that continued underfunding of this program could lead to an inability to meet the long-scheduled goal of another rover launch in 2020.

This is a real concern. Under the proposed schedule, any slip in component delivery will threaten the viability of the entire program, because scientists tell me that after 2020, the orbits of Earth and Mars will be millions of miles further apart. So further delay would only make the program more complicated and more expensive.

Does the Administration remain committed to a 2020 launch of the next Mars rover, and will the requested funding level allow the program to remain on schedule?

Answer. NASA's Mars Exploration Program has been, and will continue to be, a major success story for NASA in science, engineering, and technology development. The Administration's fiscal year 2015 budget request supports plans for a robust multi-year Mars program, which includes a budget profile for Mars 2020 that will allow the project to proceed as planned with a launch readiness date in 2020. NASA remains committed to finding the most cost-effective way to accomplish the Mars 2020 mission, and has implemented proven processes and procedures to reduce the likelihood of cost or schedule overruns. Given these factors, we are confident that the requested funding level will allow the program to remain on schedule.

Question. Since the mid-1990s, NASA has invested more than \$1.1 billion in the Stratospheric Observatory For Infrared Astronomy (SOFIA), a project that has been jointly funded with the German space agency (DLR). SOFIA recently achieved full operational capability in February 2014, just 11 days before the fiscal year 2015 budget proposed to cancel the program.

Administrator Bolden, experts and scientists working on this project in California have indicated that they were shocked by the abrupt nature of this proposed cancellation.

What was the process for reaching this assessment that SOFIA is now a "lower priority program"?

Answer. The decision to propose, as part of the fiscal year 2015 NASA budget request, to put SOFIA into storage was primarily a budgetary decision driven by the tight budget caps in the Bipartisan Budget Act of 2013. SOFIA's scientific priority relative to other missions within NASA's Astrophysics portfolio was a secondary consideration to accommodating the level of NASA's fiscal year 2015 Astrophysics budget request (\$607 million) compared with the fiscal year 2014 appropriated level (\$668 million). Hence, NASA has to make tough budget decisions in order to maximize the scientific return of the public investments in the astronomical sciences. Further, among the Astrophysics projects considered for budget reduction, SOFIA was identified for two reasons. First, it is the only strategic Astrophysics project that was not a first priority of a Decadal Survey. Second, while it was a priority in the 1990 Decadal Survey as a medium-class mission, its operations costs are the second largest of all NASA science missions, with only Hubble Space Telescope costing more.

Question. Could you explain why NASA did not follow its usual process of conducting a "Senior Review," which engages experts in the community to set priorities and make tough decisions on whether to end a mission?

Answer. Senior Reviews are reviews of the science productivity of operating missions to support an assessment, based on demonstrated science accomplishments, of the anticipated science value of an extended mission. At the time of the 2012 Astrophysics senior review, SOFIA had not entered operations and therefore had not established a baseline of science accomplishments appropriate for a Senior Review. With the successful commissioning of its fourth science instrument in February 2014, SOFIA entered its operations phase in May 2014.

Question. How will you explain to the U.S. taxpayers that the Administration has simply changed its mind and wasted the \$1 billion it spent building SOFIA?

Answer. Given today's severely constrained budgets, NASA has to make tough budget decisions in order to maximize the scientific return of the public investments in the astronomical sciences. SOFIA's high operating cost was a primary factor in the fiscal year 2015 budget proposal to put SOFIA in storage, unless alternative funding sources are found. Any alternative accommodation of the proposed reduction

in the NASA Astrophysics budget would similarly impact other Astrophysics missions. While significant funding has been spent to develop SOFIA, this funding is less than half of the estimated \$3 billion life-cycle cost of the program.

Question. As you know, SOFIA is a joint project between the United States and Germany. Germany has contributed 20 percent of the cost to develop SOFIA. Germany also built the telescope and contributed the engines and other components. Moreover, Germany has agreed to contribute 20 percent of the operating costs.

Why would NASA choose this moment to pull out of its commitment?

Answer. The decision to propose, as part of the fiscal year 2015 NASA budget request, to put SOFIA into storage was primarily a budgetary decision driven by the tight budget caps in the Bipartisan Budget Act of 2013. The memorandum of understanding (MOU) with Germany recognizes that our ability to carry through on our agreement is dependent on the availability of adequate appropriated funding. Some examples of the rich and robust NASA–DLR cooperation at the forefront of discovery include the Gravity Recovery and Climate Experiment (GRACE), the Fermi Gamma-ray Space Telescope, the Dawn mission now on its way to the asteroid Ceres, and the Mars Science Laboratory/Curiosity. Our long history of mutually beneficial collaboration will continue well in the future, bilaterally through missions like InSight, and multilaterally through the European Space Agency (ESA) where our work in development expands to such projects such as James Webb Space Telescope (JWST) and Exobiology on Mars (ExoMars)/Mars Organic Molecule Analyzer (MOMA).

Question. Are you concerned that this decision will erode trust not only between the U.S. and Germany, but also between the U.S. and other international partners on projects in the future?

Answer. No. Even the most robust space partnerships, such as those among the International Space Station partners, have weathered such developments. Our partners are very aware that in all instances our cooperation is based on the availability of appropriated funds, just as we are aware that their participation has similar funding constraints. NASA has a long history of very successful cooperation with nations around the world, and a part of that history has from time to time included some decisions by NASA and some by our international partners to re-phase, redesign, or even terminate planned cooperative activities.

Some examples of the rich and robust NASA–DLR cooperation at the forefront of discovery include the Gravity Recovery and Climate Experiment (GRACE), the Fermi Gamma-ray Space Telescope, the Dawn mission now on its way to the asteroid Ceres, and the Mars Science Laboratory/Curiosity. Our long history of mutually beneficial collaboration will continue well in the future, bilaterally through missions like InSight, and multilaterally through ESA where our work in development expands to such projects such as James Webb Space Telescope (JWST) and ExoMars/MOMA.

Other countries continue to work with NASA on a wide variety of international partnerships, and we have not observed any change in their willingness to work with us. Currently, NASA has over 600 active agreements with over 120 countries and anticipates that international cooperation will remain a cornerstone of all of its future activities.

Question. The budget notes that SOFIA will be placed in storage “by fiscal year 2015” unless other “partners are developed to support the U.S. portion of SOFIA costs.” As you know, Congress fully funded SOFIA operations for fiscal year 2014.

Does NASA intend to mothball this fiscal year despite it being fully funded by Congress?

Answer. NASA will not take any unilateral action without an appropriate re-programming notification to the Committees on Appropriations. NASA has not submitted a fiscal year 2014 modified Operating Plan to begin the shutdown process for SOFIA.

We can also confirm that the German Aerospace Center (DLR) and NASA have decided to proceed with the scheduled Heavy Maintenance Visit for SOFIA in Germany as planned; SOFIA arrived in Germany at the end of June, 2014, and the Heavy Maintenance Visit is underway.

Question. If this occurs, how feasible do you think it would be for NASA to reassemble the team, should SOFIA be restarted in the future?

Answer. It is very difficult to predict the long-term impacts on the team of mothballing SOFIA; however, NASA acknowledges that trying to reassemble the team after a period of mothballing would be difficult and could require substantial effort.

SPACE TECHNOLOGY

Question. There are several significant projects and technologies NASA identified and funded in the budget that are important for providing communications and deep space navigation technology for human and robotic exploration. For example, the Lasercom Relay Demonstration (LCRD) will provide space-based optical data relays. The use of Human Exploration Telerobotics/Human-Robotic Systems will cooperatively enhance and speed up human space exploration missions to new destinations. Another project in the Space Technology account, Solar Electric Propulsion, would leverage capabilities developed and deployed by the commercial satellite industry and expand them with NASA funded developments to meet long endurance space missions.

Do you believe the funding requested in the President's fiscal year 2015 budget is sufficient to ensure these activities continue to advance human and robotic exploration as well as science missions?

Answer. Yes. We hope that the final fiscal year 2015 appropriation for NASA will fund the entire Space Technology request of \$706 million. NASA believes this funding level requested for Space Technology will enable the technical investments needed for NASA's future science and human exploration missions. The requested funding level would allow NASA to invest in key technology development efforts including: Solar Electrical Propulsion (SEP), Laser Communications Relay Demonstration (LCRD), Deep Space Atomic Clock (DSAC), Low Density Supersonic Decelerators (LDSD), Green Propellant Infusion Mission (GPIM), Cryogenic Propellant Storage and Transfer (eCryo), Revolutionary Robotics and Autonomous Systems, and other critical technologies needed for human and robotic exploration deeper into our solar system, leading to human missions to Mars. In addition, fully funding the fiscal year 2015 Space Technology appropriations request brings new crosscutting technologies and capabilities that lower the cost for other Government agencies and the Nation's aerospace industry.

Question. What would the impact be on these innovative technologies if funding did not remain at NASA's fiscal year 2015 requested level?

Answer. A number of impacts to important efforts within Space Technology will occur should the appropriated funding level reduce below the President's budget request. The extent of the impact will depend on the funding scenario. If reductions are made from the requested levels, Space Technology will likely prioritize existing content by scaling back planned competitive awards for most Space Technology programs and slowing the start of new technology demonstrations. Reducing new competitive awards provides stability for existing efforts—especially for those near their launch readiness date, but severely impacts the technology pipeline for the Agency, resulting in a loss of capabilities and efficiencies for future missions.

At the proposed House Appropriations funding level for Space Technology, NASA will scale back competitive awards as noted above. In addition, the following Technology Demonstration Missions (TDM) would likely continue, but with increased execution risk due to the elimination of most of the program's contingency funding: Laser Communications Relay Demonstration, Deep Space Atomic Clock, Low Density Supersonic Decelerators, eCryo and Green Propellant Infusion Mission. Development of the high-priority Solar Electric Propulsion would continue, as planned. Such reductions are particularly challenging for projects planned for launch in 2015 including: Deep Space Atomic Clock, Low Density Supersonic Decelerator, and the Green Propellant Infusion Mission.

In addition, the fiscal year 2015 funding levels proposed in the House bill for Space Technology would likely result in significant de-scoping of content or potential cancellation for the following: revolutionary robotics, autonomous systems, hypersonic deployable technologies, modeling for entry, decent and landing technologies, nuclear system development, Center Innovation Fund (CIF) activities, and new awards in the Small Spacecraft Technologies (SST) program and the Space Technology Research Grants (STRG) program. Reduced funding levels may also impact risk reduction efforts for technologies being developed in preparation for the Discovery 14 opportunity including deep-space optical communication and advanced thermal protection systems.

Space Technology will prioritize technologies based on thrust areas identified as critical to increasing the Nation's capabilities in space, including those meeting the Agency's exploration and science goals. This includes advancement of Solar Electric Propulsion required for the Asteroid Redirect Mission as well as future human missions to the surface of Mars. These thrust areas also emphasize Space Technology's support of continued Mars robotic science exploration, expanding the capabilities of future outer planetary science missions, and developing the large observatory capabilities to understand the Universe. The thrust areas support Space Technology's in-

vestment strategy to enable future NASA missions while offering crosscutting support for the missions and capabilities of commercial and other government space sectors. Nevertheless, at a significantly reduced fiscal year 2015 funding level, as proposed by the Congress, critical content even within these key thrust areas will either run at risk or face elimination.

HUMAN EXPLORATION AND OPERATIONS

Question. As you know, the development of a reliable means of repairing and refueling satellites already in orbit could allow the U.S. to realize significant cost-savings and ensure the continued operation of these satellites for the benefit of civilian and national security assets. It is my understanding that the Goddard Space Flight Center is proposing to expand their work in this important area. I also understand that Goddard is building off of prior investments and leveraging industry capabilities.

Do you believe that in orbit refueling and servicing of satellites is an important research effort for NASA to undertake as a stepping-stone to support human exploration?

Answer. NASA is refocusing its In-Space Robotic Servicing activity to multi-use technology development efforts that could enable multiple NASA missions, including servicing potential science satellites, servicing government missions in low-Earth orbit, and non-NASA users, and provide robotic tools for an Asteroid Redirect Mission, as well other applications for use and/or testing on the International Space Station (ISS).

Robotic Refueling Mission phase 2 hardware will be flown to ISS in fiscal year 2014. This hardware includes a new tool and task board, which will be used to demonstrate additional refueling tasks, including robotic operations associated with cryogenic fluid transfer. In-Space Servicing is also developing a tool to detect external ammonia leaks on ISS. This device will be critical in monitoring and determining leak locations on ISS, and serve as generic tool to assist in satellite repair.

Question. Do you believe that NASA's relationships with commercial partners could be strengthened through such a program?

Answer. NASA continues to engage private industry and other government agencies to determine their interest in these capabilities.

QUESTIONS SUBMITTED BY SENATOR RICHARD C. SHELBY

HUMAN EXPLORATION AND OPERATIONS

Question. Administrator Bolden, you suggested that NASA's "total investment in the COTS program" was only \$684 million. However, by my accounting, the number is closer to \$800 million. I have attached a copy of the schedule of payments provided by your staff, which supports this number. Could you please explain why your "total investment" number is different than that which is reflected in the attachment?

Answer. While the original planned amount for the entire Commercial Orbital Transportation Services (COTS) effort was \$800 million, the actual available appropriations were \$782 million. The \$684 million represents the funding paid to the two remaining partners, SpaceX and Orbital Sciences, under COTS Space Act Agreements. The total COTS program funding paid to date is \$781 million, broken out as follows:

[In millions of dollars]

	Amount
SpaceX	396
Orbital	288
Total COTS Investment in current partner Space Act Agreements	684
COTS Investment in Terminated Space Act Agreement with Rocketplane Kistler (RPK)	32
Total COTS Investment through Commercial Resupply Services (CRS)	18
Total COTS Other Management and Support	47
Total COTS Program Payments through April 30, 2014	781

Question. It is my understanding that at least one of the providers participating in Commercial Resupply Services (CRS) has flown different variants of their launch

vehicle for each mission—some variants being more significant than others. Please provide the subcommittee a detailed accounting of each vehicle flown by mission and the changes made to that vehicle relative to the original qualifying launch vehicle. Additionally, the subcommittee requests a detailed description of the changes made, if any, from one launch vehicle to the next.

Answer. Under the Commercial Resupply Services (CRS) contract, a total of four flights have flown to the International Space Station (ISS) to date. All four flights have successfully berthed with the Space Station and delivered all planned cargo. Additionally, all three SpaceX CRS flights have successfully returned all planned cargo to Earth. The table below outlines the vendor, CRS flight, launch vehicle versions, and launch dates.

Vendor	Flight	Launch Vehicle	Launch Date
SpaceX	CRS SpaceX-1	Falcon 9 v1.0	10/07/2012
SpaceX	CRS SpaceX-2	Falcon 9 v1.0	03/01/2013
SpaceX	CRS SpaceX-3	Falcon 9 v1.1	04/18/2014
Orbital	CRS Orbital-1	Antares 120	01/19/2014

For the CRS program, there is not a NASA “qualification” of the commercial partner launch vehicle in the traditional definition. Each company is responsible for all prelaunch qualifications and verifications of their launch vehicle and is also responsible for determining what launch vehicle is appropriate for the specified mission parameters, including expected cargo upmass/downmass (as applicable), launch window and rendezvous phasing. The cargo spacecraft that berths to the ISS is required to meet a set of interface and verification requirements for each mission, which NASA reviews and dispositions for each flight. Launch vehicle performance and capability were previously demonstrated under the COTS program prior to the CRS contract vehicle launches. In addition, the Federal Aviation Administration reviews safety and performance data of the launch vehicles prior to each flight to ensure public safety and is responsible for issuing a license of each vehicle’s launch and reentry. As NASA does not contractually qualify or verify the commercial partner launch vehicles, additional information on these vehicles and their version history should be requested from the relevant company.

Question. I am aware that a number of significant anomalies have occurred with CRS launch vehicles, including seawater intrusion, engine loss on ascent, and the insertion of a secondary payload in the improper orbit just to name a few. What is the probability that such significant anomalies will occur with CRS launch vehicles and what insight does NASA have in that regard? What risk mitigation efforts are underway to ensure that these anomalies are not repeated? What is NASA’s recourse when such significant anomalies occur; for instance what can be done about the loss of or damage to payloads returning from the ISS?

Answer. Launch vehicle development and operation is a technically challenging undertaking. Efforts to reduce risks through design reviews, testing at component and system levels, and early identification of any risks are utilized to preclude anomalies.

NASA participates in various production and operations contract milestones with the vendors to gain insight on both launch vehicle and spacecraft, as part of the CRS contract. NASA insight is defined as gaining an understanding necessary to knowledgeably assess the risk of contractor actions or lack thereof through observation of manufacturing or tests, review of documentation, and attendance at meetings and reviews.

The CRS contractor has the lead for anomaly resolution for phases of the mission during which they have responsibility. In the event of an anomaly during a mission, a contractor-chaired team will determine the cause of the anomaly or failure to evaluate all available data in order to determine if the mission failure was attributable to the vehicle or conditions for which the contractor is expected to control or avoid. The appropriate corrective actions necessary to address any issues will be determined and coordinated with NASA. NASA is able to fully participate in these investigation and proposed mitigation implementation. In addition, NASA participates as necessary in any issues/anomalies that are identified during production as well.

As part of determining mission success or failure after each return mission, NASA conducts a post-flight assessment of the condition of the payloads to determine if their condition meets the agreed to requirements. If the return payloads do not meet the requirements or are lost, and the mission therefore is only a partial success or a failure, NASA withholds a portion, or the entire, final payment for that mission.

Question. Administrator during the Committee's NASA hearing on the fiscal year 2014 budget last year, you stated: "... we don't know the precise amount, because we don't get, you know, fiscal accounting the way that would be required if we were working under a FAR-based contract, but they are now working under FAR-based contracts in the CCiCap program ... We have total insight into everything that they're doing, so when we get to ready to roll out the request for proposals here this summer, we'll be confident that we know what they're doing." These comments led me to believe that FAR-based contracts would provide greater transparency and oversight than the existing Space Act Agreements. However, NASA has stated that it will waive significant portions of the FAR contracting requirements under the proposed CcTcap RFP, including those related to certified cost and pricing data. Could you explain how a waiver of these requirements is consistent with your previous statements encouraging transparency and accountability?

Answer. NASA did not waive "significant" portions of the Federal Acquisition Regulation (FAR) contracting requirements under the Commercial Crew Transportation Capability (CCtCap) Request for Proposal (RFP). NASA modified several standard FAR provisions to better align with the contract requirements, which is part of the procurement process for any solicitation. NASA approved waivers/deviations for several RFP clauses, as permitted by the FAR, because the resultant clauses were appropriate and justified for the CCtCap procurement. NASA was fully transparent with industry regarding the waivers and deviations under CCtCap RFP.

NASA did not waive any certification requirements for the initial award of proposals under CCtCap. FAR 15.403-1 does not allow the Government to require Certified Cost or Pricing Data for procurements when there is expected to be adequate price competition through multiple proposals and price is a significant factor in the evaluation, as is the case for CCtCap. As part of the competitive price evaluation, the RFP required all offerors to submit data other than cost or pricing data to assist the Government in determining price reasonableness. NASA did waive FAR 15.403-4(a) and (b)—relating to certified cost or pricing data after contract award. This waiver only applies to potential contract modifications and task orders in excess of \$700,000 during contract performance (i.e., after the award of the base contract). This was done in order to reduce administrative costs associated with the certification of cost accounting systems and to increase competition. Like the initial contract award process, NASA will require contractors to provide data other than certified cost or pricing data to assist in price reasonableness determinations for future modifications and task orders under the contract.

In addition, NASA will have significantly greater oversight under the CCtCap contract than it had under Space Act agreements, through certification of compliance with NASA requirements, inspections, anomaly investigation and safety review of hazardous flight operations. NASA will have full technical insight into commercial vehicle design and performance, and has achieved a head start on this through the recently completed first phase of this procurement, the Certification Products Contracts.

Question. How is NASA weighing individual company investment in the current round of awards to ensure that this is a public-private partnership and not a taxpayer funded development program?

Answer. CCtCap is a firm fixed price contract and, as such, NASA is concerned with the price to the Government and the contractor's ability to perform the work at that price. As part of ensuring lifecycle cost management, NASA is evaluating the financial resources proposed to meet the milestones throughout the contract and how the total investment affects performance risk. NASA is not evaluating the magnitude of company investment.

Question. What is the current investment level for each participant in Commercial Crew thus far?

Answer. By the time the Commercial Crew Integrated Capability (CCiCap) is completed, NASA's investment in the three rounds of Commercial Crew Space Act Agreements (CCDev, CCDev2, and CCiCap) will be \$1.533 billion. Based on representations by the companies, our industry partners will have made an aggregate investment of approximately 20 percent of the total investment through the completion of the Commercial Crew Integrated Capability (CCiCap) phase. The actual aggregate investment of the partners may be higher to the extent that industry has absorbed cost growth associated with hardware development challenges and schedule delays. A further level of definition regarding any company's investment in the Commercial Crew Program would be proprietary to that company and is Sensitive But Unclassified information.

NASA has also provided an aggregate \$29 million to industry for the Certification Products Contracts. The corresponding partner investment is unknown, but the

partners are believed to have contributed to this activity, as the generation of these products has proven to be even more significant than we or they anticipated.

Question. I am concerned about the lack of transparency inherent in Space Act Agreements and, in particular, the lack of information NASA has regarding the private investment in both the commercial cargo and crew program. Does NASA know how much each participant has invested in the cargo program or the crew program? Are the companies required to disclose their investments as a condition of their contract with NASA?

Answer. By the time the Commercial Crew Integrated Capability (CCiCap) is completed, NASA's investment in the three rounds of Commercial Crew Space Act Agreements (CCDev, CCDev2, and CCiCap) will be \$1.533 billion. Based on representations by the companies, our industry partners will have made an aggregate investment of approximately 20 percent of the total investment through the completion of the Commercial Crew Integrated Capability (CCiCap) phase. The actual aggregate investment of the partners may be higher to the extent that industry has absorbed cost growth associated with hardware development challenges and schedule delays. A further level of definition regarding any company's investment in the Commercial Crew Program would be proprietary to that company and is Sensitive But Unclassified information.

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The industry partner investment under the COTS development program was a higher percentage than the percentage for crew development. For the ISS Commercial Resupply Services (CRS) contract, NASA is purchasing services under fixed-price contracts. NASA has no insight into any partner investments made in delivering that service. Companies have not been required to disclose their investments as a condition of award of a crew or cargo contract. The CRS, CPC, and pending CCtCap contracts are all fixed-price contracts, which do not require the contractor to disclose its expenses or investments.

Question. Is it reasonable that to speculate that these companies have invested less than 5 percent of their own money in these ventures? If they are not required to disclose their investments, how do you know whether they have invested \$5 or \$5 million?

Answer. By the time the Commercial Crew Integrated Capability (CCiCap) is completed, NASA's investment in the three rounds of Commercial Crew Space Act Agreements (CCDev, CCDev2, and CCiCap) will be \$1.533 billion. Based on representations by the companies, our industry partners will have made an aggregate investment of approximately 20 percent of the total investment through the completion of the Commercial Crew Integrated Capability (CCiCap) phase. The actual aggregate investment of the partners may be higher to the extent that industry has absorbed cost growth associated with hardware development challenges and schedule delays. A further level of definition regarding any company's investment in the Commercial Crew Program would be proprietary to that company and is Sensitive But Unclassified information.

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Question. NASA has a significant number of launches that it intends to launch on board Space X rockets over the next several years. In 2014 alone, NASA ISS resupply missions account for 4 of the 13 missions listed on their manifest. However, we are now in May and only 2 of the 13 missions listed have launched. With only 8 months remaining, they will have to launch every 22 days for the rest of the year. This would be more launches in 8 months of a Falcon 9 than have been completed over the past 3 years. Given the critical nature of resupplying the ISS, how is NASA preparing for the possibility that the scheduled launches to the ISS by Space X will not occur as scheduled?

Answer. The remaining two flights planned for fiscal year 2014 are planned for July 2014 (Orb-2) and August 2014 (SpX-4). In addition, the European Space Agency plans to launch its Automated Transfer Vehicle-5 this summer. The commercial strategy does not rely on a single flight or provider, but if CRS cargo delivery flights fall behind schedule, NASA will prioritize the cargo carried on those flights on the basis of payload criticality to the maintenance and operation of ISS. Beyond meeting these requirements, NASA will first satisfy additional requirements associated with NASA utilization missions including NASA-sponsored Biological and Physical Research, the Human Research Program and Technology Development and Demonstration projects necessary to NASA's exploration mission. Finally, NASA would work together with the Center for the Advancement of Science in Space (CASIS), which manages the National Laboratory aspects of the ISS to determine the priority of utilization-related cargo, including equipment and samples supporting research objectives by organizations other than NASA.

QUESTIONS SUBMITTED BY SENATOR LISA MURKOWSKI

SCIENCE MISSIONS

Question. The National Aeronautics and Space Administration (NASA) is identified as a supporting Federal agency for 9 elements of the Implementation Plan for the National Strategy for the Arctic Region, including:

- Enhance Arctic Domain Awareness;
- Develop a framework of observations and modeling to support forecasting and prediction of sea ice;
- Implement the Pilot Distributed Biological Observatory in the Pacific Arctic;
- Develop Integrated Ecosystem Research in the Beaufort and Chukchi Seas;
- Improve Understanding of Glacial Dynamics;
- Understand Terrestrial Ecosystem Processes;
- Understand Atmospheric Processes to Improve Climate Predictions;
- Support a Circumpolar Arctic Observing System; and
- Integrate Arctic Regional Models.

Despite this long list of action items, NASA references only two Arctic-oriented projects in its fiscal year 2015 Budget Estimates document:

- Operation IceBridge*—which consists of 26 science flights from Fairbanks and Greenland to collect data on sea ice, ice sheets and glaciers; and
- ICESat-2*—which will continue assessments of polar ice changes once launched in 2017.

These are important projects, and I am not going to criticize NASA for pursuing good work related to the Arctic. However, as I have been with many other Federal agencies I am concerned that the statements made in the Administration's Arctic Implementation Plan are not matched with resources to support actual work when it comes to NASA. Administrator Bolden, could you please provide me with information regarding your agency's fiscal year 2015 budget support for the 9 action items where NASA is identified as a supporting agency?

Answer. NASA's fiscal year 2015 budget estimates document does not cover all of the agency's activities because it was focused on major items listed as specific milestones in the strategy. The strategy and milestones were derived from the Arctic Research Plan fiscal year 2013–2017 developed by the Interagency Arctic Research Policy Committee (IARPC), in which NASA regularly participates. Apart from our major investments in IceBridge and ICESat 2, NASA spends an additional approximately \$20 million on Arctic research across a range of NASA science-based programs, as follows:

- Cryospheric Sciences*: Supporting a diverse suite of studies of Arctic sea and land ice. The sea ice studies are especially focused on the connections of changes in sea ice cover to climate drivers. The land ice studies are especially relevant to estimates of present and future sea level rise.
- Interdisciplinary Sciences*: Supporting studies of the impacts of Arctic change on the global system, and ice–ocean interaction.
- Making Earth System data records for Use in Research Environments (MEASURE)*: Supporting various studies compiling information on Arctic sea ice, Greenland ice sheet, and North American snow cover.
- Modeling and Assimilation*: Supporting model development for sea ice components of global climate models and ice sheet models relevant to sea level rise.

- Carbon Cycle*: Supporting development of the Arctic Boreal Vulnerability Experiment (ABOVE) campaign, a major study planned for 2015 and beyond to assess the changes occurring in Arctic vegetation.
- Earth Ventures*: Supporting aircraft studies to assess the release of greenhouse gases from the thawing permafrost.

These funded activities contribute to all of the elements listed above, and detail can be provided as desired.

Question. As Arctic ice continues to diminish and more and more nations engage in that region, I have encouraged this Administration to lead in the Arctic and dedicate the resources necessary to back up our claims of Arctic engagement.

Administrator Bolden, I am aware that the Canadian Government is looking at a new satellite mission that would help maintain satellite communications and weather observations in the Arctic region for years to come. This comes at a time when our own civil weather satellite capability faces an “unacceptably high” probability of a gap in observations by 2017. The U.S. Navy in its Arctic Roadmap has highlighted the importance working with Canada on Arctic communications and weather. In addition, a recent GAO report cited that weather forecasts over the Arctic needed to be improved.

While I understand that the National Oceanic and Atmospheric Administration (NOAA) is the lead agency for weather satellite programs, I would like to know your views on satellite observations needed in an increasingly ice-diminished Arctic. Also, could you please describe how NASA is engaged with NOAA and the Department of State (DOS) to evaluate the benefits that a Canadian communications and weather satellite mission would have to the U.S. and our monitoring capabilities?

Answer. Satellite observations of the Arctic region have already proven to be important for advancing our understanding of the ongoing changes there, as well as enabling the U.S. to plan for the large effects that can be expected in the future.

NASA’s current and planned satellite observations provide extensive coverage of the Arctic. Most of NASA’s satellites are in polar orbits, which fly over each pole approximately 15 times per day, gathering data routinely during these overpasses and transmitting and processing data back on the ground for use by the research and applications communities. Planned satellite data such as the ICESat 2 mission (launch in 2018) and GRACE Follow On (launch in 2017) will provide particularly important measurements of ice sheet topography and mass, respectively. NASA coordinates with the Canadian Space Agency and that nation’s Environment Canada agency, both bilaterally and through international coordinating entities such as the Committee on Earth Observation Satellites (CEOS) and the Coordinating Group on Meteorological Satellites (CGMS); NOAA participates along with NASA in both CEOS and CGMS. NASA Earth Science Division and NOAA/National Environmental Satellite, Data, and Information Service (NESDIS) regularly exchange information on international interactions and potential future opportunities in the context of the NASA–NOAA Joint Working Group mandated by Section 306 the NASA Authorization Act of 2005. NASA also regularly participates with the Department of State on Arctic-related issues, including those associated with the Arctic Council, and in interagency activities such as IARPC and the development of the National Arctic Strategy and the associated Implementation Plan.

Although we are aware through CEOS of Canada’s interest in developing a Polar Communications and Weather (PCW) satellite mission, their plans have not reached the stage of maturity at which they are presented for detailed discussion among the U.S. Government agencies.

Question. As an Alaskan, I have an acute interest in the weather data provided by the Joint Polar Satellite System (JPSS). The impending gap in this critical data and the lack of robustness in the overall program is of great concern to the Nation and especially to my constituents. Secretary Pritzker addressed the gap in a recent hearing with this committee (April 10, 2014) by stating, “. . . what we’re trying to do is move JPSS–2 so that there’s greater overlap with the JPSS–1 program. To do that, we need to have the procurement of the instruments, the bus, the ground system, and the launch.”

As the acquisition agent, what is NASA currently doing to assist NOAA in accelerating JPSS–2?

Answer. NASA and NOAA are assessing options to possibly accelerate the JPSS–2 Launch Readiness Date (LRD) from its current baseline of first quarter of fiscal year 2022 in order to reduce the probability of a gap between JPSS–1 and JPSS–2. NASA is actively working procurement actions for the complement of instruments as well as the spacecraft bus in order to get all under contract as soon as possible. The schedules of the instruments currently drive the JPSS–2 schedule. One instrument is already under contract, and final contract negotiations are underway for the other instruments. NASA plans to have all JPSS–2 instrument contracts definitized

by Summer 2014. In addition, NASA plans to release the Request for Offer for the JPSS-2 spacecraft bus on schedule by the end of the fourth quarter fiscal year 2014. NASA is applying lessons learned from the JPSS-1 instruments and spacecraft manufacturing, integration and testing phase to the JPSS-2 mission planning, which should permit some level of acceleration.

CONCLUSION OF HEARINGS

Senator MIKULSKI. This subcommittee stands in recess subject to the call of the Chair.

[Whereupon, at 10:30 a.m., Thursday, May 1, the hearings were concluded, and the subcommittee was recessed, to reconvene subject to the call of the Chair.]